# POWER

Vol. 38 NEW YORK, JULY 1, 1913 No. 1

*Drawn by C. H. Greene*

A GOOD SUGGESTION, WELL EXPLAINED, ACCOMPLISHES MORE THAN A MULTITUDE OF COMPLAINTS

# Power Plant of the Madison Avenue Building

By Thomas Wilson

*SYNOPSIS—A small noncondensing, office-building plant carrying a lighting, elevator and power load and using exhaust steam in a vacuum system for heating.*

❖

In the uptown business center of New York City, a great many new office and loft buildings are being erected. Notwithstanding the advantages and the saving that might be effected with a private plant, most of these buildings are using Edison current. An exception is the Madison Avenue Building, located on the corner of Twenty-fifth St. and Madison Ave. The structure covers

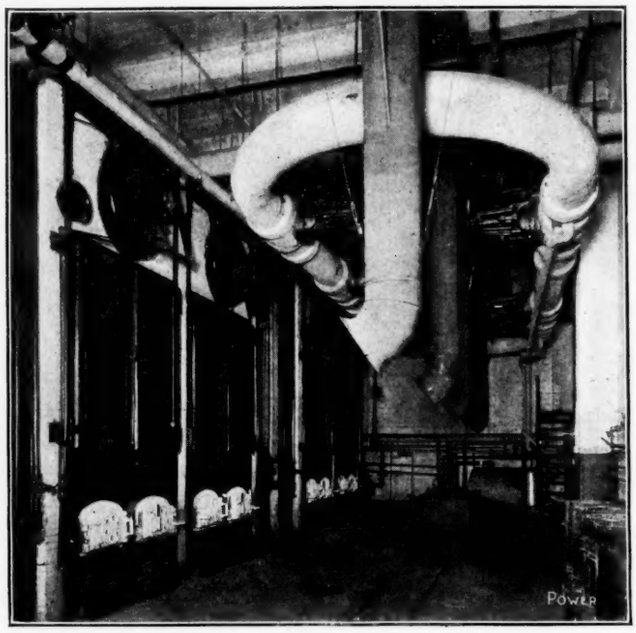



Fig. 1. Boiler Room

an area of 15,000 sq.ft., is 20 stories high, has a floor area of 300,000 sq.ft. and is to be used as a combination office and loft building.

The power plant, located in the sub-basement, 35 ft. below the street level, supplies the lighting, elevator service and heating. A good layout and good substantial equipment are the features of the plant.

The boiler room is equipped with four 200-hp. B. & W. water-tube boilers arranged two in a battery. The gases are discharged into a brick flue running over to the inside corner of the building and discharging through a steel stack 325 ft. high. The arrangement of the piping is shown in the plan view of the boiler and engine rooms. It will be noticed that a ring header is provided and equipped with valves so that any boiler can supply any unit in the engine room. A 6-in. U-header attached to the back connections of the boilers supplies the pumps and also live steam to the feed-water heater, which is of the "700 series" Cochrane type, having capacity to heat water for 750 boiler horsepower.

Feed water may be taken directly from the heater, the air-separating tank of the heating system, or directly from the city mains. Two 9 and 5 by 10-in. Worthington duplex end-packed plunger boiler-feed pumps of the pot-valve pattern are installed. There are also two 14 and 7¼ by 12-in. duplex fire pumps and the piping is so arranged that any one of the four pumps can supply the boilers, although the fire pumps can supply cold water only. Ordinarily they are used on the house service, and keep the tanks at the top of the building filled with water.

A Climax damper regulator is installed and is connected to a balanced damper in the main smoke flue. One Ellison draft gage serves the four boilers. A small brass pipe connects each flue with a manifold attached to the inlet of the gage. A valve in each pipe makes it possible to take a reading on each boiler separately, and the four readings in rapid succession.

No. 2 buckwheat coal is burned in the boilers. It is stored in coal pockets at the end of the boiler room, which receive their supply from the street and have a capacity of 450 tons. From the pockets the coal is conveyed to the boilers on an industrial coal car and hand fired directly into the furnaces. An electric-driven sidewalk lift of 1700 lb. capacity removes the ashes.

The plan view and the photographs show the layout of the engine room, which is equipped with four direct-conected generating units, made up of McIntosh & Seymour engines and General Electric three-wire, direct-current generators. There are two 12x15-in. piston-valve engines driving at 275 r.p.m., 75-kw. generators and two 15x32-in. four-valve engines running at 150 r.p.m. and connected to 150-kw. generators. Both engines have flywheel governors and heavy flywheels, weighing 2200 and 12,000 lb., respectively.

When the building is fully occupied one large and one small unit will be sufficient to handle the load. The other two units will be held in reserve and obviate the necessity of Edison breakdown current. It will be noticed that the units are arranged along the walls to give plenty of room in the center and to permit the operator to face the switchboard when throwing in a machine. The switchboard is equipped with the usual line of instruments. It

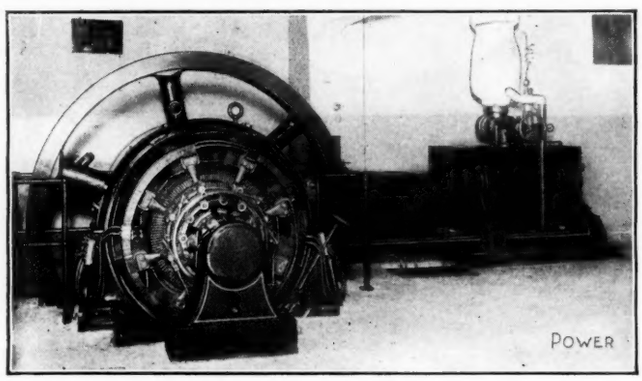



Fig. 2. One of the 150-Kw. Units

contains seven panels: four generator, one tie panel and two feeder panels, the lighting panel being at one end of the board and the power panel at the other. There are two sets of busbars, so that the lighting and power loads may be separated and may be supplied with energy from any one of the four units. When one unit is supplying the en-

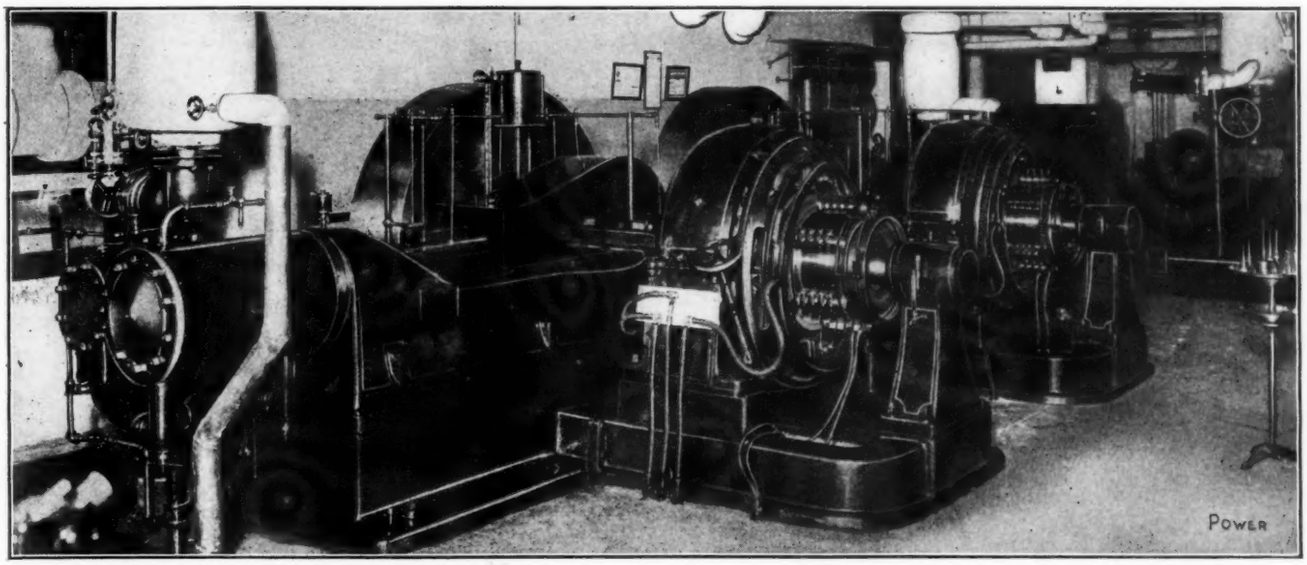



FIG. 3. THE TWO 75-KW. UNITS

tire load the busbars are thrown together by means of the tie panel At the time of the writer's visit only one machine was running and there appeared to be no difficulty in operating the lights and elevators from the same supply.

Exhaust steam is used for the heating with provision for live steam when necessary. The connections of the exhaust steam piping are shown in the accompanying plan. From the last unit to the heater, the exhaust pipe is 14 in. in diameter, and its continuation to the riser supplying the heating system or to the atmospheric exhaust is 12 in. in diameter. The Dunham vacuum system heats the building. There are 47,000 sq.ft. of radiating surface and a typical radiator connection is shown in Fig.

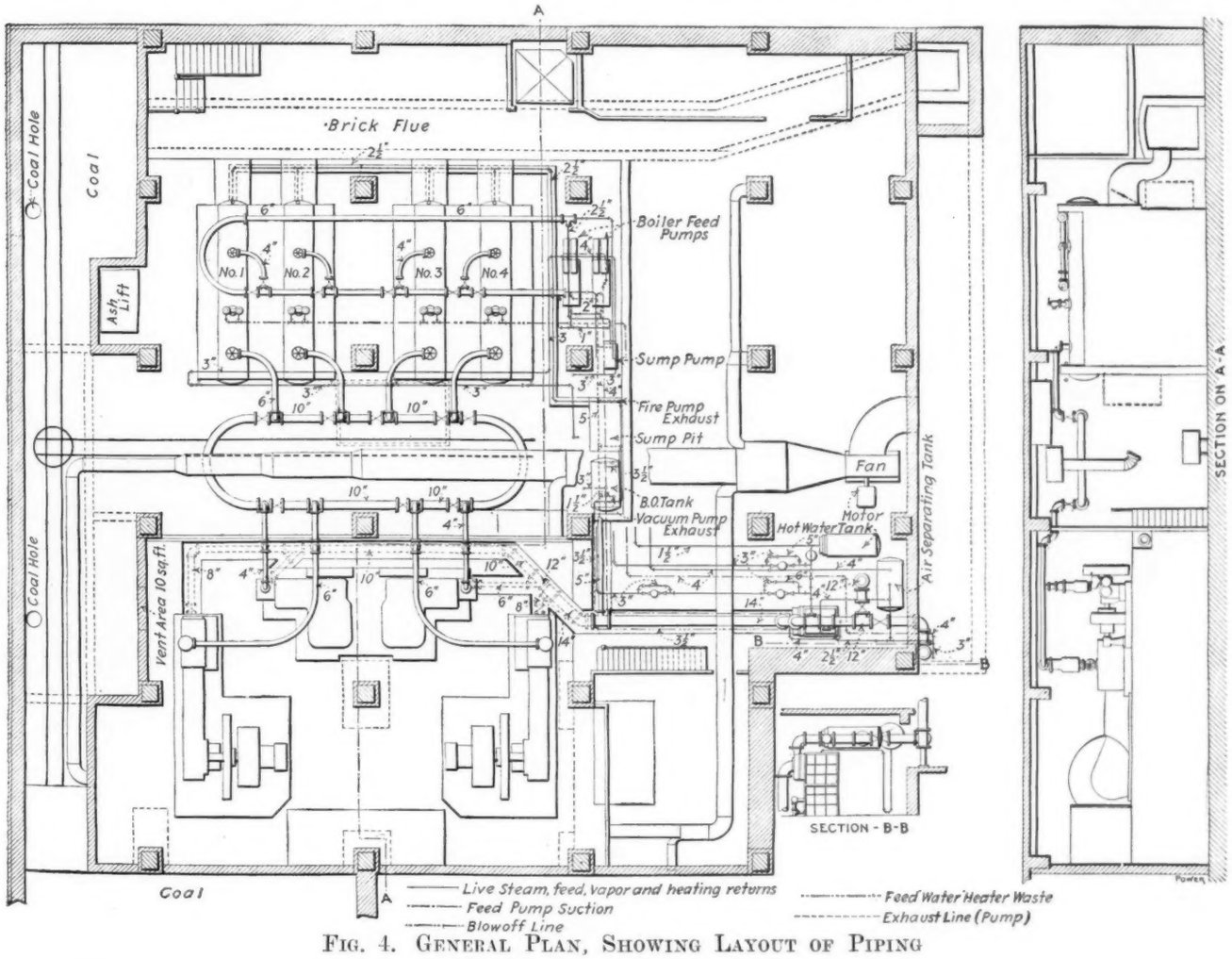



FIG. 4. GENERAL PLAN, SHOWING LAYOUT OF PIPING

6. On the return end of the radiators 1½-in. Dunham valves have been provided. From here the return line is ¾ in. in diameter and the main return is 4½ in. This is connected through a gate valve and suction strainer to the suction inlets of the two vacuum pumps, which are 8

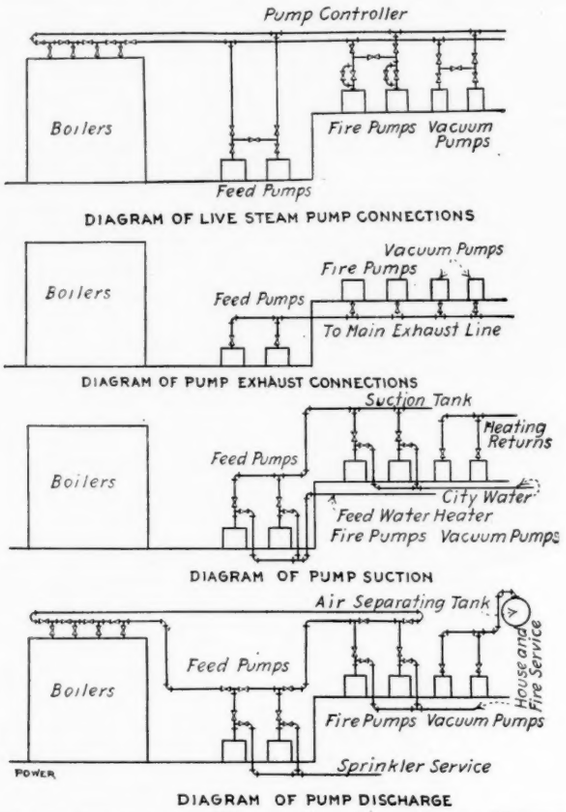



FIG. 5. STEAM AND WATER CONNECTIONS OF PUMPS

and 12 by 12-in. A vacuum of about 10 in. is carried at the pumps. The discharge of each pump is carried through gate and check valves and connected into a common line which in turn discharges into the air-separating tank. The steam lines to the pumps are connected through vacuum governors provided with bypasses.

A total of 13 elevators, seven passenger and six freight, serve the building. Five of the passenger elevators are operated by 35-hp. motors at a speed of 700 ft. per min. The other two, which run from the basement to the fifth floor, are served by 25-hp. motors at a speed of 500 ft. per min. The freight elevators operate at a speed of 400 ft. per min. and are all served by 35-hp. motors. The entire elevator equipment was supplied by the A. B. See Co.

The results obtained in the acceptance test, made by Clark, MacMullen & Riley, who were the engineers for the building, may be of interest. The determination of

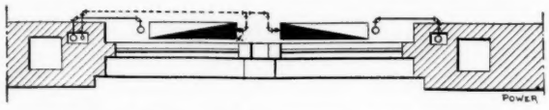



FIG. 6. TYPICAL RADIATOR CONNECTION

the water rate was limited to one engine of each type, as the units were exact duplicates.

As the plant is arranged so that any two units may be run independently of each other, the house load during the test was carried by one engine operated from one of the boilers, while the engine under test was operated from another boiler, with a separate feed pump. This permitted the exact amount of water used by this boiler to be measured by the usual two-barrel method. The load consisted of resistance coils under running water and was

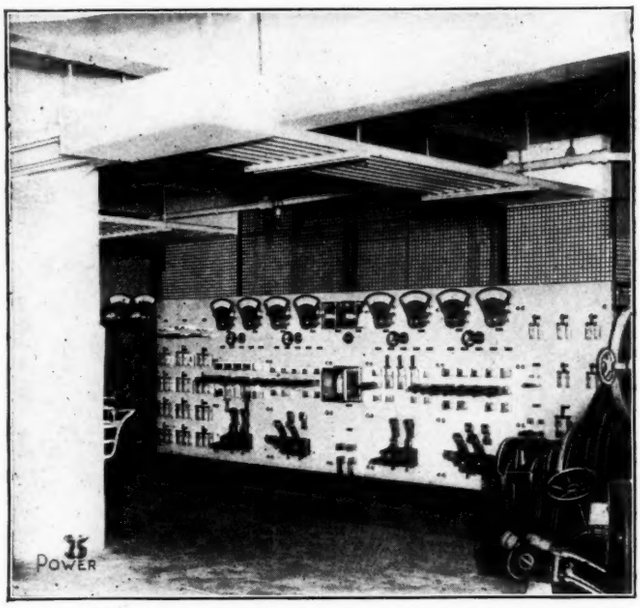



FIG. 7. SEVEN-PANEL SWITCHBOARD

maintained nearly constant throughout both tests. A rate of 22.5 lb. of dry steam per indicated horsepower-hour was obtained on the larger engine while the smaller engine required 33.6 lb. of steam.

## Standard Smokeless Furnace

An arrangement of boiler furnace and auxiliary heating device put out by the Standard Fuel Reduction Co., 55 Liberty St., New York City, is illustrated herewith. The maker states that this furnace when installed, will not only eliminate smoke within the law, but will increase the efficiency of the boiler.

As shown in the sketches *A* and *B*, Fig. 1, one tube of the return-tubular boiler is removed and a pipe connection made with the boiler head. This pipe is connected to the end of a larger pipe, which extends across the furnace at a height about level with the bridgewall. The opposite end of the cross pipe is connected to the rear boiler-head tube opening. An extension of the horizontal pipe passes out through the rear boiler brick wall.

Just above the cross-circulating pipe is a second, but smaller pipe, in which a series of nozzles are arranged opening toward the rear of the boiler. This nozzle pipe is protected from direct contact with the furnace flames. One end of the pipe is plugged and the other is attached to a vacuum globe, as shown in sketch *A*. This globe holds a vertical air pipe. At the bottom of the vacuum globe a connection is made with a steam pipe connecting with the steam space of the boiler. The inner connection ends with a steam nozzle so placed that the outlet is central with the center of the horizontal nozzle pipe and discharging into it longitudinally, as shown at *C*.

When steam is turned into the steam nozzle a partial vacuum is created in the vacuum globe and air is drawn

in through the vertical pipe, which extends above the top of the boiler setting. This mixture of steam and air escapes through the several nozzles and mingling with the escaping gases in the combustion chamber, produces smokeless combustion.

The volume of air entering the vacuum globe is controlled by the amount and pressure of steam escaping through the steam nozzle.

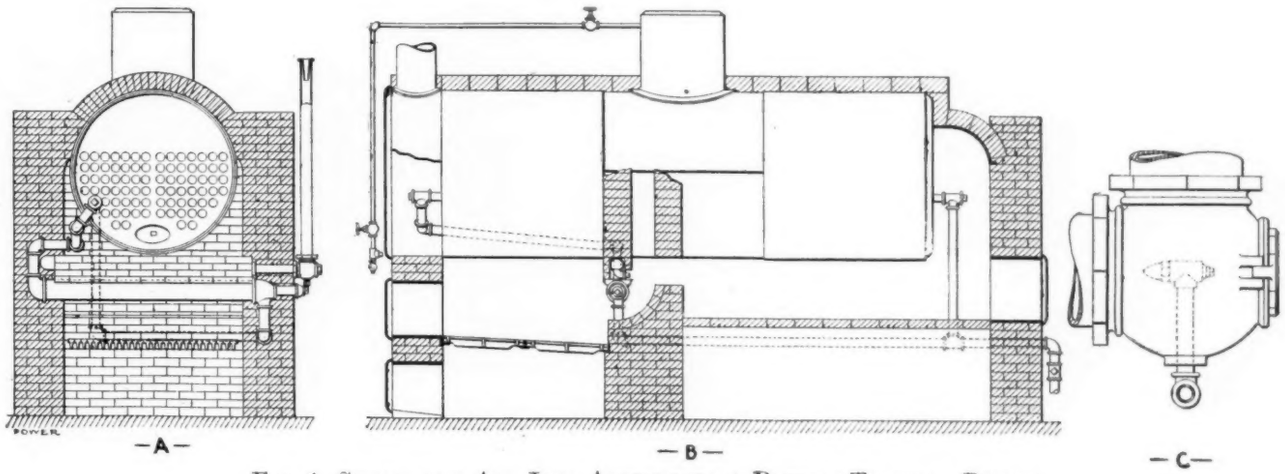



FIG. 1. STEAM AND AIR JETS APPLIED TO A RETURN-TUBULAR BOILER

As a further aid to combustion the chamber at the rear of the bridgewall is filled in and lined with brick. The curvature of the bridgewall forces the gases from the furnace to pass between the horizontal water pipe and the bridgewall, so that the mixture of steam and air is enabled to mingle with the gases in the combustion chamber.

In Fig. 2 is shown the arrangement of steam and air jets when applied to a water-tube boiler. The baffle wall above the bottom row of bricks extends from the front and rear ends of the furnace with an opening in the center through which the flames pass to the first pass of the boiler in the direction of the arrows.

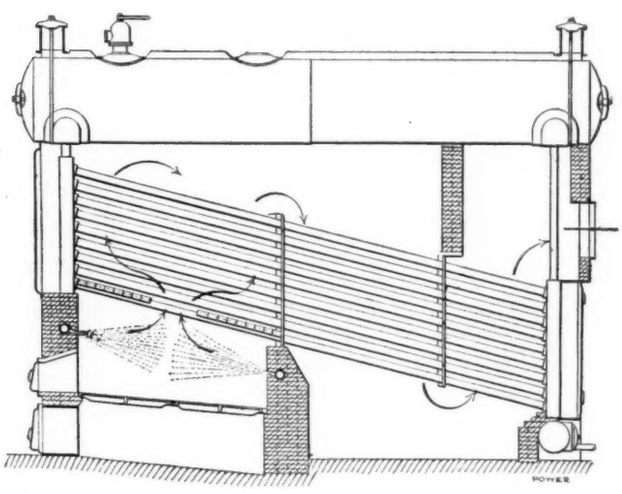


FIG. 2. AIR NOZZLES APPLIED TO FURNACE OF WATER-TUBE BOILER

This furnace is put in under a boiler on 30 days' free trial basis by the manufacturers in order to prove their guarantee.

## A Large Air Compressor

*Zeitschrift des Vereines deutscher Ingenieure* for Apr. 19, of the current year, says that in common with all engines used in the mining and blast-furnace industries the present-day makes increased demand on the air compressor, and illustrates and reviews the more salient feature of an unusually large example of such latter equipment.

Up to about 10 years ago compressors with an hourly output of 350,000 to 400,000 cu.ft. were of the largest in use. Today almost double that duty has been reached without a material increase of floor space. Several of these large machines have been furnished by Rud. Meyer, of Mulheim on the Ruhr, for the Rand mines in the Transvaal country. They have the following dimensions:

| | |
|---|---|
| Diameter of steam cylinders | 31x62 in |
| Diameter of air cylinders | 54x33 in |
| Common stroke | 50 in |
| Speed | 65 to 72 r.p.m |
| Free air intake per hr. | 565,000 to 644,500 cu.ft |
| Total weight | 176 tons |
| Diameter of flywheel | 21.8 ft. |
| Face of flywheel | 26 in. |
| Total floor space | 1560 sq.ft |
| Normal duty | 1700 to 1750 hp. |
| Widths of air-cylinder pistons | 52.75 and 44 in. |
| Diameters of air nozzles | |
| High-pressure side | 17 in. |
| Low-pressure side | 28 in. |

The steam cylinders have the Doerfel positive valve-gear; the air cylinders Meyer disk valves for high rotative speeds. The steam end is run condensing and its cylinders are jacketed with live steam. The machine is unprovided with tail rods and guides, notwithstanding the long stroke rendered unnecessary by the construction of the air pistons.

The acceptance test showed the following results: Mechanical efficiency, 89.25 per cent.; volumetric efficiency, 98.7 per cent.; steam consumption, 11.28 lb. per i.hp.-hr. at a pressure of 172 lb., a temperature of 482 deg. F. and a vacuum of 25 in.; air temperature at a pressure of 89.5 lb. behind the low-pressure cylinder, 203 deg. F.; behind the high-pressure cylinder, 196 deg.; showing an advantageous working of the intercooler in as much as temperatures of 212 to 230 deg. are generally counted on.

Electrically operated reciprocating compressors have thus far not attained such service; the largest of these delivering from 318,000 to something over 400,000 cu.ft. per hr. at speeds of 104 to 125 r.p.m.

# Mixed-Pressure Steam Turbine*

By L. G. Hanmer

*SYNOPSIS—The cardinal advantages of the mixed-pressure steam turbine are presented, showing how the exhaust steam from a reciprocating engine is utilized, and how live steam can be used to operate the unit when no exhaust steam is available.*

❖

Assuming a plant in which 2000 boiler horsepower is generated, there must be 60,000 lb. of steam, which, after being used in an engine, escapes as exhaust steam. If this exhaust steam were utilized in an exhaust-steam turbine where every 60 lb. of exhaust steam would produce a kilowatt, 1000 kw. would be generated, which costs nothing.

Exhaust steam, however, is not always without value to a manufacturer, and in many cases is utilized in processes of manufacture wherein a certain fixed temperature has to be maintained.

In almost every plant, exhaust steam from various sources is utilized in a feed-water heater, a point which should be carefully considered before assuming that all exhaust steam is pure gain. For instance, in the assumed 2000-hp. plant, 60,000 lb. of water is converted into steam every hour. Therefore, 60,000 lb. of feed water at a temperature of, say, 70 deg., should be raised to a temperature of, about 200 deg.; with a heater of roughly 70 per cent. efficiency, approximately 11,400 lb. of steam would be required, leaving 48,600 lb. of steam for other work.

Assuming that the steam has been used in various small steam engines, pumps, etc., and that 30 per cent. has been condensed, there would remain but about 34,000 lb. of steam available for the turbine, etc., of which 20,000 lb. may be utilized in processes of manufacture and which is consequently not available for power generation. The remaining 14,000 lb. of steam, if utilized in an exhaust-steam turbine, would be sufficient to generate 335 kw., which might be considered as clear gain, exclusive of interest and depreciation on the investment, oil and maintenance. These items should not represent more than 12 per cent. on $11,000 or $1320, plus, say, $600 for oil and maintenance, which would be $1920, say, $2000 per year. Assuming a plant to run but 10 hr. per working day at full load, that means 3000 hr. a year, and as 335 kw. is generating from exhaust steam there would be generated 1,005,000 kw.-hr. per year, at a total cost, including interest, depreciation and maintenance, etc., of $2000 or less than two-tenths of a cent per kilowatt-hour.

This example in generalities, is a typical condition, and indicates what is to be looked for in an exhaust-steam turbine proposition.

[Dealing with the theory of the exhaust-steam turbine, the speaker pointed out that heat, which in steam is the real source of power, can be converted into mechanical work only by the expansion of the steam; that theoretically the moisture in the exhaust from an engine expanding from 150 lb. gage to atmospheric pressure is about 15 per cent., but on account of reëvaporation, which takes place in the engine cylinders during the expansion part of the stroke, this will, in practice, be found to be nearer 10 per cent., and approximately as much heat is available for doing work from atmosphere to 28 in. of vacuum as when expanding from 150 lb. gage to atmospheric pressure.—Editor.]

*Excerpt from a lecture delivered before Melville Council, No. 9. Universal Craftsmen, Friday, May 16.

## Economy of Low-Pressure Turbines

An exhaust-steam turbine, designed to properly expand the steam, will turn more of the heat into work when working on this low-pressure range than a high-pressure turbine or an engine when working on high pressure range, expanding from 150 lb. gage to atmospheric pressure, because the frictional or windage loss of the exhaust turbine is very small since the rotors run in a vacuum.

Tests have shown there is a reduction of 8 per cent. in the steam consumption of a turbine when it is exhausting into a 28-in. vacuum over the steam consumption with a 26-in. vacuum. In other words, for a given amount of exhaust steam, 8 per cent. more available work can be secured by carrying a 28-in. vacuum than can be secured by carrying a 26-in. vacuum.

In the long run a 28-in. vacuum is advisable, but in order to maintain it nearly twice as much water must be circulated through the condenser as would be required to maintain a 26-in. vacuum, and at the expense of a certain amount of power to drive the circulating pump; it means an increase in the cost in the condensing apparatus of approximately 40 per cent. It may be that these items, when figured in dollars and cents and when depreciation is taken into account, would not show an economy commensurate with the investment, in which case it is well to keep the first cost low by using a condenser capable of maintaining a 26-in. vacuum.

In general, the steam economy of a simple engine and an exhaust-steam turbine operating together, is always an improvement over that which would be obtained by compounding the simple engine. The plant capacity is increased from 50 to 100 per cent. by exhausting through an exhaust turbine to a condenser on a noncondensing engine; the increased capacity obtained by adding the turbine to a condensing outfit, is from one and one-half to three times that which could be secured from the condenser alone.

Like the high-pressure turbine, the low-pressure turbine operates at nearly uniform efficiency over a wide load variation while the economy of a reciprocating engine is not good when the latter is under- or overloaded. Therefore, the combination of the engine and the low-pressure turbine will give more uniform economy at all loads than will the engine alone.

When more power is required the plant owner has three alternatives in securing it. First, he may install a larger or additional engine, which is an expensive proposition, requiring additional boiler capacity, perhaps involving expense for enlarging the buildings, and increasing labor and upkeep costs materially.

Second, more power may be secured by running the old engine condensing, but no engine either simple or compound, even when operating at the best economical point of cutoff and otherwise under the best conditions

can deliver over 20 to 25 per cent. more power than when running noncondensing.

The third method is that of changing the engine to run condensing, and utilize the additional range of pressure drop to drive an exhaust-steam turbine, making is possible not only to almost double the amount of power previously secured from the engine, but doing it without increasing the duty on the engine and without using any more steam than before.

The initial cost of the turbine and condenser per horsepower is less than for additional boiler and engine capacity. The turbine and condenser fit into a very small space, and as the combination takes the same quantity of steam as would the engine alone and under the same conditions as before, there is not an additional penny of expenditure necessary for boilers, chimneys, draft, coal-handling apparatus, building and steam piping. The turbine and condenser, or turbine alone in a condensing plant, can be cut into the exhaust line without interfering in any way with the engine and usually without altering the layout of the plant.

The installation of the turbine hardly affects plant-operating costs, as the turbine seldom requires other attention than occasional lubrication and repacking of stuffing-boxes. The oiler who has previously been taking care of the engine can look after the turbine without any serious drain on his time.

An engine that has previously been running noncondensing continues to exhaust at about the same pressure and carries the same load after the turbine is cut into the exhaust line. A condensing engine can be adjusted to exhaust at atmospheric pressure or thereabout and will be relieved of that part of the load assumed between atmospheric pressure and the vacuum while the turbine is being operated. The water of condensation will be discharged from the condenser at a temperature within two or three degrees of the theoretical and can be utilized in the usual ways.

### Other Advantages

An exhaust-steam turbine develops power largely from energy which, with a reciprocating noncondensing engine, must be wasted or at best used in heating systems or for preheating feed water. The amount of mechanical work obtainable from a reciprocating engine is limited by the number of expansions possible in its cylinder. Even when using steam at the earliest point of cutoff only about 20 expansions are possible in a single-cylinder engine, while compounding will not permit of more than 30 expansions, and even under the most favorable conditions when running condensing, the engine does not exhaust to the condenser at less than 5 lb. absolute pressure or 20 in. of vacuum.

The turbine, on the other hand, is capable of utilizing very nearly the complete range of expansion and thus develops the extra power. The turbine, being specially adapted to handle the larger volume of steam after partial expansion in the engine cylinder and permitting the further expansion through the lower pressures, easily and without exceeding moderate dimensions permits the further constant change of heat into work until the vacuum of the condenser is reached. The mechanical loss in the turbine is largely due to windage. The mechanical friction in the turbine is practically nothing compared to that within the reciprocating engine, and as the exhaust port is larger than the steam passages, the full value of the condenser pressure is available. The maximum amount of work from the steam is obtainable only where the engine is augmented by the turbine.

Exhaust-steam turbines will convert about 50 per cent. of the available heat below atmospheric pressure into work, so the addition of the turbine to the engine, and the relieving of the latter of the work done below atmospheric pressure, can safely be said to offer a power increase of not less than twice that which would be secured by merely changing a noncondensing engine to run condensing.

### Operating Details

In most cases the ordinary exhaust-steam turbine is on an electrical load, the fluctuations of which are entirely remote and in no ways simultaneous or similar to those which occur to the mechanical load from which the turbine derives its supply of exhaust steam.

One way to handle this condition is to connect in the electrical load of the turbine, a synchronous motor, belted to a line shaft, which is part of the mechanical load. In the event of the normal electrical load being light, and the mechanical load heavy, the motor acts as a motor, transferring power from the turbine to the line shaft, reducing the steam in the mechanical system and consequently the supply of exhaust to the turbine, thus affecting the balance.

In case the electrical load is heavy and the supply of exhaust steam inadequate, then the motor acts as a generator parallelled on the electrical system, thus increasing the demand on the mechanical system and reducing the demand on the turbine in the electrical system.

Another method which is useful in cases of momentary interruptions of adequate steam supply is the regenerator in which the heat from excess steam is stored to be reimparted when the supply diminishes. This scheme calls for a cumbersome and expensive equipment and applies only in very few instances.

In the mixed-pressure turbine, any deficit of exhaust steam is made up from a high-pressure line from which the high steam-pressure supply is automatically cut off when the supply of exhaust steam again becomes adequate. In the case of wide fluctuations both in the load on the turbine and on the mechanical system there will be times when exhaust steam escapes to the atmosphere, through the relief valve, while at other times there may be required a considerable amount of live steam to make up the deficit.

To offset these drawbacks, are the following considerations in favor of the mixed-pressure arrangement. Its low cost over straight low pressure; its simplicity, and consequently its dependability; the fact that in nearly every case mixed-pressure turbines may be so designed as to strike a happy medium between the minimum and maximum conditions; its extreme flexibility to all possible load conditions between one-quarter load and 50 per cent. overload. Perhaps most important of all, to the small isolated plant, is the fact that a mixed-pressure turbine may be utilized to develop its full-rated capacity on high-pressure steam in the case of a serious interruption of, or breakdown in, the machine furnishing the supply of exhaust steam.

# Air in Surface Condensation*

*SYNOPSIS—Some results of tests of condensing apparatus to determine the amount of air leakage in standard condensers and the effect of such leakage on the working of the apparatus. Curves are reproduced to show the falling off in vacuum, due to air leakage, and the effect of load on such leakage.*

In view of the lack of knowledge of this subject, the author determined to investigate:

a The amounts of air contained in feed water and

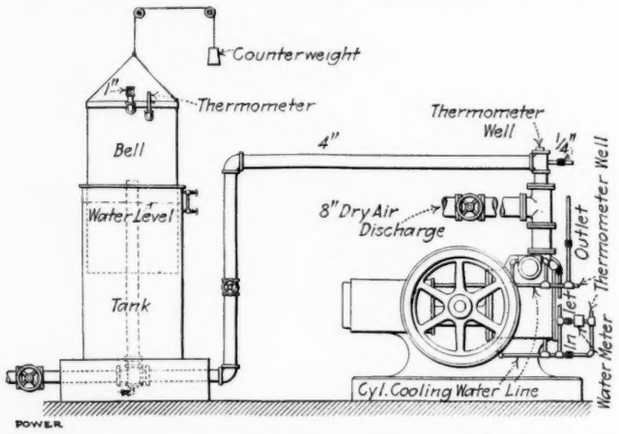



FIG. 1. GASOMETER FOR MEASURING AIR LEAKAGE INTO CONDENSER

those entering the condenser through the prime mover.

b The amounts of air removed from the condenser by means of the air pump.

c The effect of known quantities of air on the action of a surface condenser of commercial size.

The author's investigations were made at the Waterside No. 2 station of the New York Edison Co., and the water samples were taken both from the suction and discharge sides of the feed pump. The average temperature of the feed water during the tests, after having passed the heater, was about 190 deg. F. It was thought possible that there might be air bubbles mechanically entrained in the water, besides the amount of air in solution. To determine the amount of this entrained air, samples of the water were allowed to flow through a measuring apparatus. The water entered through a tube and passed to the top of a measuring cylinder where the air separated and was collected at the top of the cylinder; the water flowed out of the cylinder through a tube into a glass demijohn where it was measured. These tests were started with the apparatus entirely filled with water. The air collected was measured at atmospheric pressure by means of a pressure-regulating cylinder. The temperature of the air was determined by a theromometer in the measuring cylinder.

Test results showed that Croton water gives off most of its dissolved air in passing through the open heaters, the amount of air occluded in the feed water (0.931 per cent.) being comparatively small. At 81 deg. F. and 2 in. of mercury absolute pressure when saturated with water vapor, this amount of air would occupy between 20 and 30 per cent. of the volume of the condensed steam. The fact was established that very little air came into the condenser from the feed water.

Having obtained the portions of air which enter the prime mover along with the steam, the next object of investigation was to determine the amount of air abstracted from the condenser by the air pump. Here, again, there were no precedents; but it was determined to catch the air over water in a gasometer. For this purpose the discharge pipe of the air pump was piped to a gasometer bell located in the basement in the vicinity of the air pump. The arrangement of this outfit is shown in Fig. 1.

After the air pump had been running long enough to make sure that the conditions were constant, the valve was opened and the discharge from the air pump allowed to enter the bell, permitting it to rise. The time required to fill the bell was noted with a stop watch and from these data the amount of air delivered was calculated. The air in the bell was brought to atmospheric pressure and temperature before the final readings were taken.

Other tests were made with the pump shut off from the condenser to determine the air leakage in the pump itself and also with the suction piping blanked off at the condenser to determine the pipe leakage.

In the experimental apparatus used to obtain the data for the paper on "The Transmission of Heat in Surface Condensation,"[1] it was impossible to detect any difference of temperature due to the segregation of air in the various parts of the single-tube condenser. On the large condensers on which these air tests were made, such a difference of pressure and temperature does exist, the difference of pressure being quite strongly marked. The curves for a number of these condensers, showing the increase in drop with the increase in amount of steam consumption, are illustrated in Fig. 2.

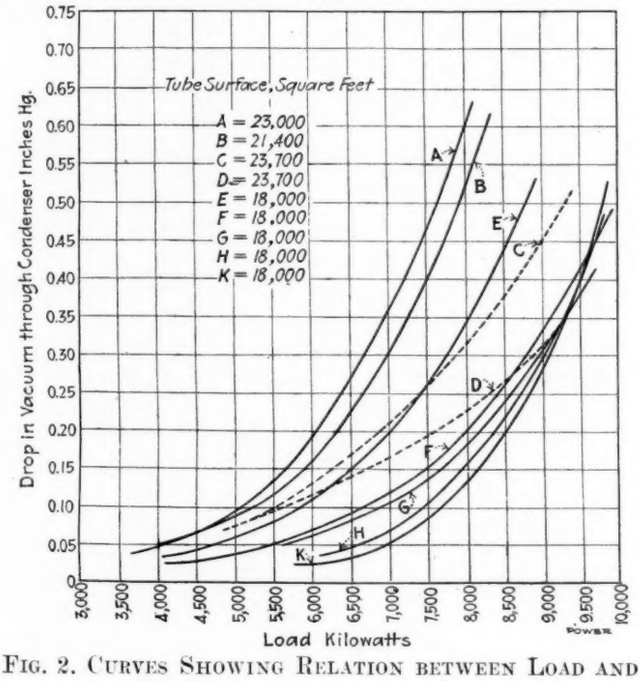



FIG. 2. CURVES SHOWING RELATION BETWEEN LOAD AND DROP IN VACUUM THROUGH CONDENSER

A number of experiments were made to find if this

*Excerpts from a paper by Geo. A. Orrok and from discussions of the paper, Journal of the American Society of Mechanical Engineers, November, 1912, and February, 1913.

[1]Trans. Am. Soc. M. E., Vol. 32, p. 1139.

drop was continuous through the tube surface or whether there were restrictions concentrating the drop in one or more places, and a number of experiments were made to reduce the amount of drop by taking out tubes, thus opening channels into the body of the tube surface. The results here were apparently negative.

To ascertain the effect of known quantities of air on the vacuum, suitable orifices of various sizes were made at the top of the condenser so that the introduced air might mix with the incoming steam. The orifices were of the ordinary circular form through thin plates and the amounts of air entering the condenser were checked up by the air delivered into the air bell from the air pump. These results are shown in Fig. 3.

The tests in each case were made at constant load, which was considerably below the capacity of the condenser.

Four sets of tests were run to determine the effect of load on air leakage, two on machines which were in bad condition and two on comparatively tight machines. The results are shown in Fig. 4. It should be noted that in every case the air leakage is less at the higher loads.

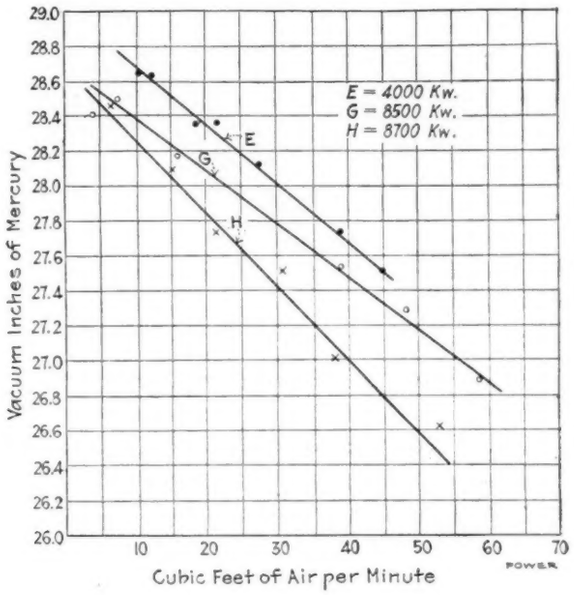



FIG. 3. CURVES SHOWING EFFECT OF AIR LEAKAGE AT CONSTANT LOAD

Where open heaters are used, very little air is carried to the prime mover with the steam. The volume of this air at atmospheric pressure and temperature will probably not exceed 1 per cent. of the volume of the feed water. As the whole system is under pressure from the pump nearly to the final stage of the turbine, no air leakage can take place up to that point.

The air discharged by the dry-air pump at atmospheric pressure and temperature from units between 5000 and 20,000 kw. in size varies from 1 cu.ft. per min., when the units are in the best condition, to 15 or 20 cu.ft., where ordinary leakage is present, and to 30 or perhaps 40 or 50 cu.ft., where the units are in a very bad condition.

Most of this leakage comes into the condenser and exhaust passages through minute leaks in the cast-iron shells, gaskets and expansion joints. It is exceedingly difficult to detect these leaks with a candle flame, but most of them may be detected by filling the condenser with warm water under a slight head. That portion of the leakage occurring in the dry-air pump and piping may be detected by the shutoff test on the pump. The volume of this leakage is larger than is generally supposed and is much larger when the pump is warm.

The drop in vacuum through condensers of standard design is larger than it should be and a design which more freely admits the steam to the tube surface should give better results. The opening of the channels into the surface will not always improve conditions. The results indicate that wide, shallow condensers should give better results; although, in at least two instances, deep, narrow condensers gave good results.

The falling off of vacuum with increased air leakage is considerable and the work necessary to maintain tight condensers more than pays for itself.

During these experiments, in which four different kinds

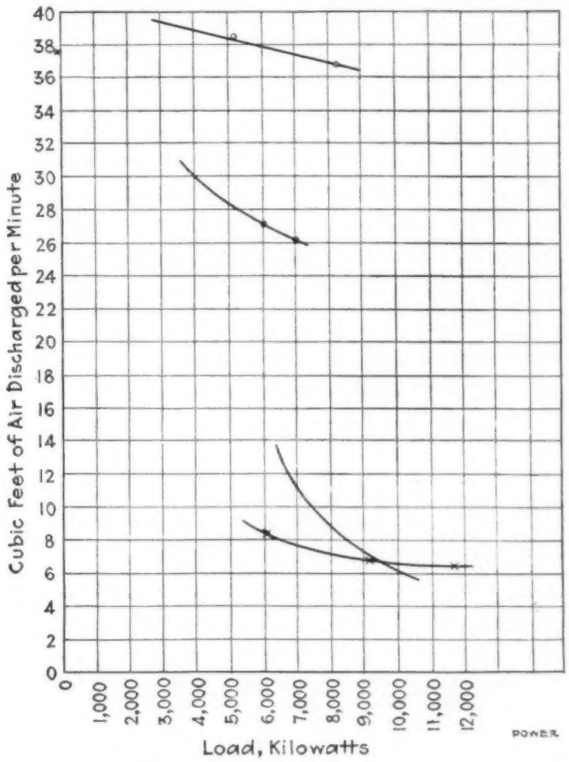



FIG. 4. CURVES SHOWING EFFECT OF LOAD ON AIR LEAKAGE

of dry-air pumps were investigated, it became evident that the volumetric efficiency of a pump working between ¼ and 15 lb. absolute is very poor indeed. The difficulties of keeping valves, pistons, glands and packing tight against such a tenuous fluid as air at vacuum pressures are of much greater moment than is usually believed. It is hoped that some of the types of kinetic air pumps will reduce considerably air leakings at these joints.

Considerable difficulty was experienced in securing vacuum temperatures during these experiments and most of the work has been repeated a number of times where such temperatures are essential. It has been impossible, up to the present time, to secure readings which were entirely consistent and the work along this line will be carried on until the cause of the discrepancy is ascertained and correct figures obtained.

In the discussion on Mr. Orrok's paper, the following interesting information was brought out:

Some years ago it was noted in a barometric-condenser installation that air leakage was apparently taking place under high vacuum through the cast-iron pipes themselves, as the vacuum could be improved by painting the pipes with asphaltum. The piping was well made and apparently free from blow-holes.

Considerable trouble was experienced in preventing air leaks through the gaskets under the end heads, especially after the pipe had been heated up. Hence, the bolts and gaskets at the joints should receive particular attention when air leaks are suspected.

The tests were not conclusive with regard to the effectiveness of the different paints in reducing vacuum losses. Paints with asphaltum base were very effective in preventing leaks at low temperatures, but softened and tended to drip at temperatures from 210 to 225 deg. F., which would occur should the vacuum fail. One paint, said to be a linseed-oil preparation with a peroxide of iron base, formed a close impervious film on the piping and showed no deterioration from the temperature change within the range of tests.

The theory advanced by several writers that seems to

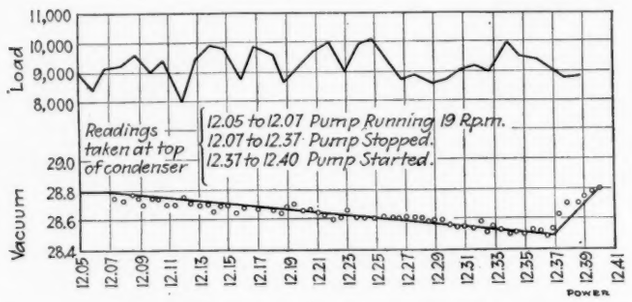



FIG. 5. SHOWING GRADUAL DROP IN VACUUM AFTER STOPPING AIR PUMP

account in the best manner for the fall in vacuum, with increased quantities of air, is as follows: As steam condenses on the tube surface, the air is left behind and the medium surrounding the tube then contains proportionately much greater quantities of air than the steam entering the condenser. The pressure of this air lowers the partial pressure of the steam and, consequently, its temperature. Hence, there is a less temperature difference between the tubes and the steam and, therefore, the rate of condensation is lowered. This theory emphasizes the necessity of providing in the design for a rapid sweeping away of the air to the air pump as fast as the steam condenses.

In connection with Mr. Orrok's figures as to the amount of air entering through the prime mover, the following data, showing the amount of air entering through turbine seals, may be of interest. They were obtained by the Wheeler Condenser & Engineering Co., with their portable testing gasometer, similar in design to Mr. Orrok's, and may serve to emphasize the importance of maintaining proper pressure on the steam seals.

In the test in question, which was made on a jet condenser, serving a 2000-kw. turbine, at no load and with no steam on the turbine seals, a total of 86 cu.ft. of free air per min. entered the condenser, a corrected vacuum of 26.6 in. being maintained under this condition. With an ordinary amount of steam on the seals and a mercury manometer registering a slight pressure, 64 cu.ft. per min. entered the condenser at no load and the vacuum was raised to 28.5 in. On a similar unit of like size, approximately the same figures were obtained: With a load of 1650 kw. on the turbine, and no steam on the seals, 91 cu.ft. of free air per min. entered the condenser, the vacuum dropping to 25.9 in. corrected. With normal steam pressure on the seals, the amount of air was reduced to 56 cu.ft. and the vacuum increased to 28.1 in. A further increase of pressure on the seal was found to have no appreciable effect.

It is to be hoped that the time will come when every power station will be equipped with a gasometer or a similar device for testing for air leaks. As it is now, the condenser manufacturer must design his air pumps to handle not only the air which he knows by experience will enter with the steam or by infiltration; in addition, he must assume the responsibility for turbine seals, for careless pipe joints and for slipshod maintenance. That is, he must proportion his air pumps to handle far more air than should be necessary and the net result is a considerable overall loss. It is no exaggeration to say that probably over 75 per cent. of the vacuum troubles in condensers today may be traced directly to an abnormal air leakage. It is to be hoped that further investigations, similar to Mr. Orrok's, will be made, in an attempt to determine the air displacement necessary, say, per 1000 lb. of steam under standard conditions.

The benefit of operating upon a closed system and cutting out the air as much as possible is unquestionable; Fig. 5 shows the effect of stopping the vacuum pump of one of the Boston Elevated units. It was realized from past experience that the vacuum upon the system would not suffer seriously even if the dry-vacuum pump were stopped temporarily, and James D. Andrews, chief engineer of the plant, kindly consented to stop the vacuum pump on one of the units for one-half hour, making one-half-minute observations of the fall in vacuum. This unit was developing 9000 to 10,000 kw. and carrying a vacuum equivalent to 1.03 in. absolute pressure when the pump was shut down. In one-half hour the vacuum had fallen only 0.32 in., or to 1.35 in. absolute. This curve is almost a straight line between the two points showing that the drop in vacuum is substantially uniform.

::

## Indian River (Canada) Developments

The Halifax Power Co. is planning to develop two sites on the Indian River, 18 miles west of Halifax. The upper station will include two units of 1200 kv.-a. each. One operates on 90 ft. head from the Indian River watershed and the other on 160 ft. head from the North-East River watershed; the latter water is carried over to the Indian River by means of a long pipe line. The lower station will include two units of 1200 kv.-a. operating on 90 ft. head; in this station the step-up transformers and high-tension gear will be placed.

These developments will render 5600 hp. available in Halifax, which will be carried over a duplicate transmission line by two separate routes. Transmission will be at 33,000 volts. It is the intention of the company to sell this power for lighting and industrial requirements in Halifax. Plans are well under way for the upper development, one transmission line and receiving station, and it is expected that this portion of the work will be proceeded with immediately.

# Bristol Recording Differential-Pressure Gages

A new line of recording differential-pressure gages has recently been developed by the Bristol Co., Waterbury, Conn. Some of these recorders have been in successful service continuously for four years, and the design and construction of the instruments now being placed on the

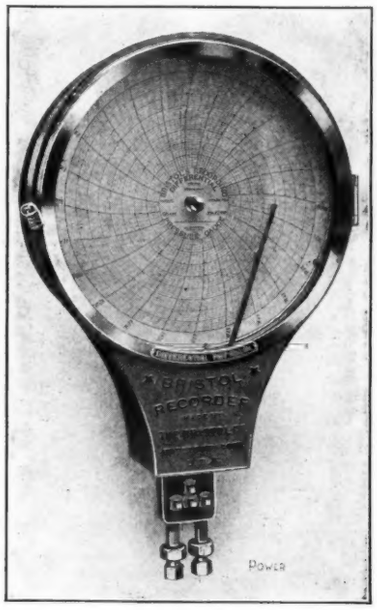



FIG 1. BRISTOL RECORDING DIFFERENTIAL-PRESSURE GAGE

market is based on results obtained in actual service during this time. Fig. 1 is an exterior view.

These gages are designed for use in connection with venturi meters, pitot tubes, orifices, combinations of orifices and pitot tubes, etc., and thereby to record velocities and volumes of air, gas, steam, water and other liquids flowing through mains and pipes. These recorders may also be used to advantage for recording differences and variations of liquid level in steam boilers, pressure tanks, filter beds, process kettles, etc.

The fundamental principle employed in the construction of this differential-pressure gage is that one pressure is applied to the inside of the operating tube while the other is applied to the outside of the same pressure tube within a closed casing. To record the movement of the pressure tube it becomes necessary to transmit its motion to the outside of the pressure-tube casing. As the differential pressure to be recorded is usually small, as compared with the static pressure, the operative force is correspondingly small. As it is impractical to use a stuffing-box around a shaft passing through a pressure casing, on account of the friction, a frictionless sealing device is employed.

In Fig. 2 is shown a hollow, helical, pressure tube. The two pressures, the difference of which is to be recorded, are applied, one to the interior of this tube through the lower right-hand pipe, the other to the exterior through the other pipe. The pressure tube is entirely inclosed in the pressure-tight casing. The movement of the pressure tube will be in proportion to the difference between these two pressures, and this motion is transmitted to the recording pen arm, outside of the pressure casing, by a small shaft through a long tubular sleeve. The capillary action of the oil or liquid between the sleeve and shaft makes this joint both frictionless and pressure tight.

In Fig. 3, the pressure-tight casing incloses the diaphragm pressure tube. Here, also, one pressure communicates with the interior and the other with the exterior of the tube, and its motion is transmitted by a rotating shaft through a sleeve to the recording pen arm. The length of this sleeve is many times the diameter of the shaft passing through it, unlike an ordinary bearing.

This device permits of recording extremely small differences between the pressure existing inside and outside of the pressure tube. The frictionless sealing sleeve through which the pen-arm shaft passes does not produce appreciable resistance to the rotation of the shaft, and capillary attraction and adhesion prevent leakage of even high pressures from the pressure casing.

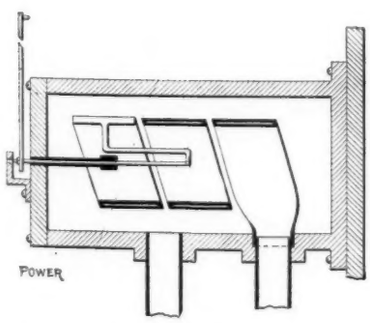



FIG. 2. INTERIOR OF HELICAL PRESSURE TUBE

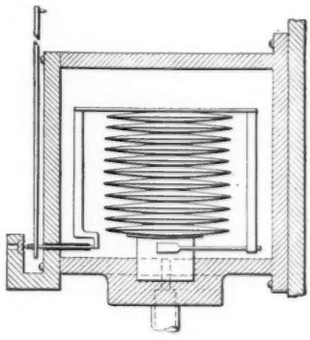


FIG. 3. INTERIOR OF DIAPHRAGM PRESSURE TUBE

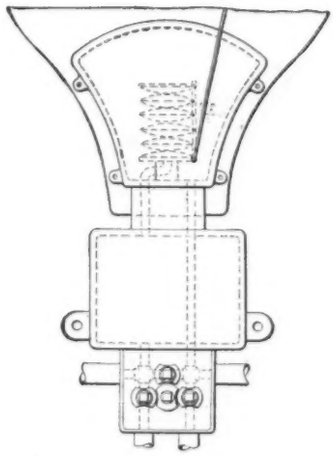


FIG. 4. CONNECTIONS FOR DIAPHRAGM-TYPE GAGE

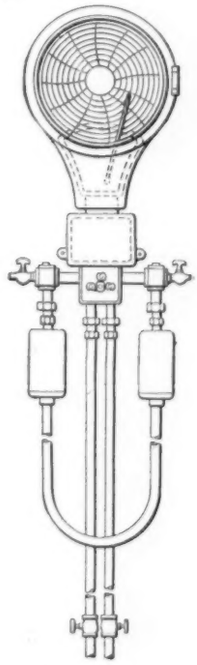


FIG. 5. SAFETY DEVICE

In Fig. 4 a diaphragm tube is shown in the pressure chamber of the casing directly connected to one end of the rotating shaft passing through the pressure seal, and

having its other end directly connected to the recording pen arm.

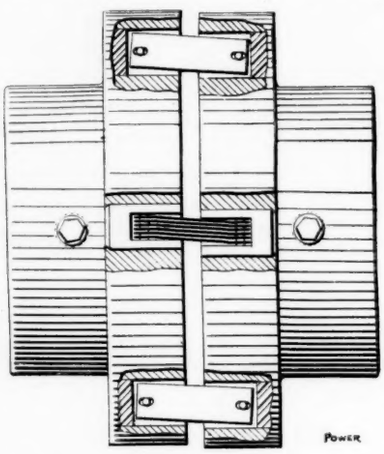
This illustration also shows a set of interlocking valves, which constitute a device for adapting recording differential-pressure gages to practical operating conditions. The upper cross-valve is shown in an open position connecting the two pressure pipes. The two lower valves in the pressure pipes are shown closed. Both of these valves can be opened, allowing the static pressure from either pipe to be applied simultaneously to the inside and the outside of the pressure tube of the actuating mechanism. The lower central or interlocking member can then be turned through an angle of 90 deg., making it possible to close the upper valve, which completes the connections so that the instrument will record the difference between the two pressures.

In Fig. 5 is shown a patented safety device consisting of a U-shaped tube, partly filled with a liquid such as mercury or water. This tube has enlarged chambers, having sufficient volume to accommodate the quantity of liquid contained in the tube. The length of the U-tube varies with the range of the gage so that the greatest possible head of the liquid contained in the U-tube corresponds with the total range of differential pressure the gage is designed to record. Should the full static pressure accidentally be admitted to either side of the differential gage, the liquid contained in the safety U-tube would instantly be forced up into one of the enlargements, thus allowing the static pressure to be applied simultaneously to both inside and outside of the pressure tube, thus protecting it from being destroyed.

❋

## Francke Flexible Coupling

Flange couplings are usually tied together with ordinary bolts, making a rigid joint. The Francke flexible coupling, marketed by the Smith-Serrell Co., 90 West St., New York City, is also an ordinary flange coupling




FRANCKE FLEXIBLE COUPLING

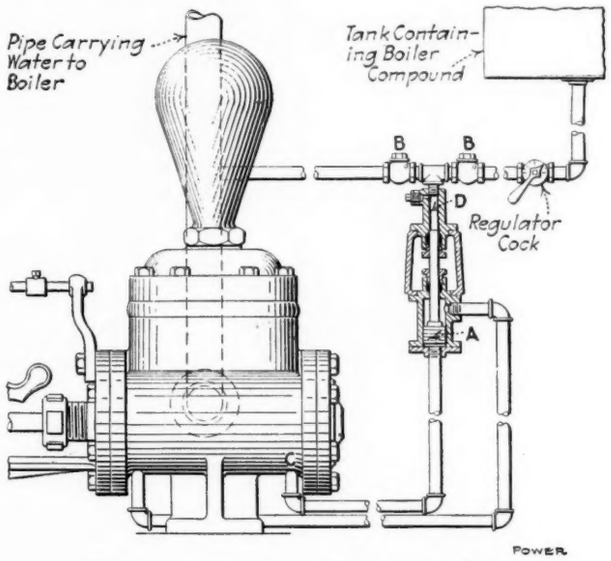
but is connected by flexible bolts. They are made of tempered-steel leaves, held at each end by a keeper which prevents their working loose. The keepers are slotted at each end to engage spring rings which fit in a groove in the coupling flanges.

All leaves except two short ones at each end are slotted. The short ones are held stationary, making all movement come on the steel leaves, which do the work that is distributed over a large area. The slots in the leaves allow the coupling to adapt itself to any misalignment of the shaft.

❋

## Taber Automatic Boiler-Compound Feeder

This compound feeder is designed to operate in unison with the boiler-feed pump and to automatically stop feeding when the pump stops. It can be attached to any make of pump. In reality the feeder is a water-operated




TABER AUTOMATIC COMPOUND FEEDER

plunger pump, the piston of which is actuated by the water pressure from the discharging ends of the boiler-feed pump. The plunger of the feeder runs in a cylinder, which is fitted at one end with a stuffing-box; the other end is connected to a tee to which the two check valves *BB* are screwed. One check valve is piped to the tank containing the compound solution, the other is piped to the discharge pipe of the boiler-feed pump. The arrangement is shown in the illustration. A regulating cock is piped in between the tank and the feeder by which the amount of compound fed to the boiler is adjusted.

The action of the compound feeder, which is built by the Taber Pump Co., Swan and Ellicott Sts., Buffalo, N. Y., is as follows: As the upper and lower sides of the plunger piston *A* are connected to the water ends of the water cylinder of the feed pump, when the pump plunger moves toward the end *C*, the water pressure produced in that end of the cylinder is exerted against the under side of the feeder piston *A*, which is forced upward, discharging the compound in the chamber *D*, out through the left-hand check valve *B*, into the discharge pipe, where it mingles with the feed water passing to the boiler.

On the reverse stroke of the boiler-feed pump water is forced into the feeder cylinder above the piston *A*, which forces it downward and a charge of compound is drawn into the chamber *D* from the compound tank. The discharge stroke then forces it into the feed water. For every stroke of the feed pump there is a corresponding stroke of the compound pump, and no water is fed to the boiler without receiving a certain amount of compound.

# ELECTRICAL DEPARTMENT

## Automatic Reversing Starter

By James A. Seager

Where a motor has to be reversed, unless special means are provided, it is necessary to have a main switch or circuit-breaker, a starting resistance and a reversing switch. These three separate items in the hands of an inexperienced person afford possibilities for mistakes, inasmuch as the use of them in the wrong order may mean trouble.

For this reason many devices have been put upon the market for making the control of reversible motors as automatic as possible. One of the latest of these is that brought out by Jules Hofle, of Budapest, which is illustrated in Figs. 1 and 2, showing the front and back views respectively. This is a combination of a reversing switch, a resistance switch for inserting and cutting out starting resistance, and a main switch or series circuit-breaker, and also a dashpot for the switch lever of the resistance switch. These are mechanically connected so that they act successively in starting and stopping, and the motor can be started only with the entire series of starting resistance in circuit. Moreover, the current is not interrupted either on the reversing switch or on the resistance switch, but only on the main switch or series circuit-breaker. Hence the attendant has to watch only this one point.

The slab carries a pivot, about which the starting-switch lever moves. This lever carries a contact brush and also a lug at the top, which engages the series switch lever mounted on a pivot above it. This series switch lever is under the control of a spring tending to pull it toward the right so as to close the circuit. It is, however, prevented from doing so by the lug on the starting-switch arm so long as this is in its extreme upper position. On the lower part of the slab are mounted segmental contacts and a two-armed lever attached by a pin and connecting-rod to the starting switch. The ends of these contacts are so close together that in the off position of the switch they are connected by the brushes, and should the brushes slide over the ends, the circuit cannot be broken. The starting-resistance lever which is loose on its pivot moves with this contact brush over the contacts connected with the starting resistance, and has a lug normally resting against the lug of the lever of the connecting-rod. Thus the starting-resistance lever moves downward as soon as the short lever descends while it is raised again when the latter lever is moved upward. In order that the starting-resistance lever may move down slowly and gradually a dashpot is provided to control the motion.

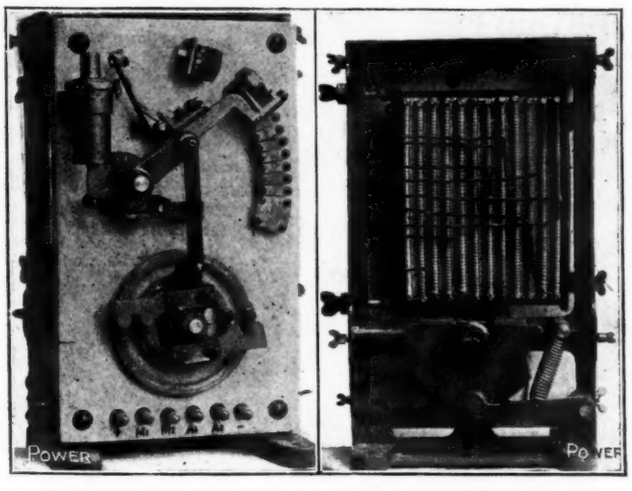



Fig. 1. Front View Fig. 2. Rear View

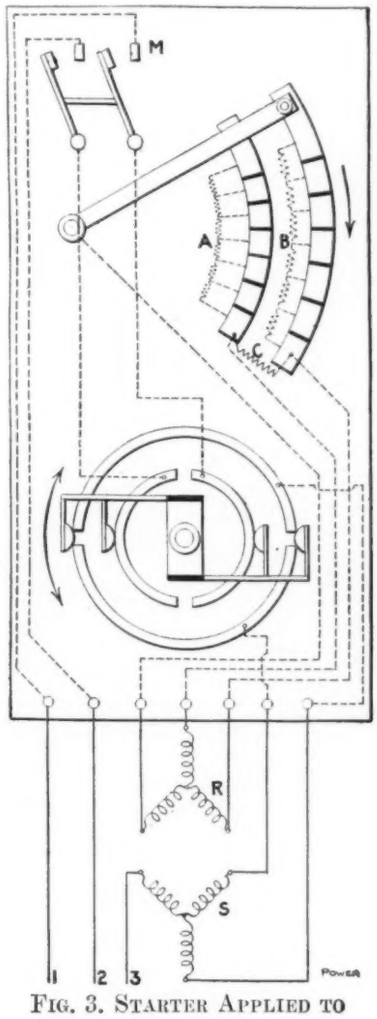



Fig. 3. Starter Applied to Three-Phase Current

Referring to Fig. 2 there will be seen a pulley fixed to the shaft passing through the slate at its lower end, and when this is rotated the brushes slide over the segmental contacts and at the same time the short lever in contact with the starting-switch lever is rocked downward by the action of the connecting-rod. If the pulley is moved in the reverse direction the brushes slide over the alternate contact segments, and thus the "change-

over" action takes place, causing the motor to run in the reverse direction. Hence, the direction of rotation of the motor is fixed immediately before the current is supplied.

As soon as the starting lever commences to travel down, the lug on its upper surface clears from the projection on the lever of the series switch, and the spring pulls the latter into contact whereby the main circuit is closed.

By a very slight modification of the reversing contacts the apparatus may be adapted to three-phase work. This is illustrated in Fig. 3. Here $R$ represents the rotor winding and $S$ the stator winding of the motor. Two conductors are connected by means of a double-pole main switch $M$ with the two inner contacts on the reversing switch, while the third conductor is connected directly to one phase of the stator. Three sets of starting resistance $A$, $B$ and $C$ are provided for the rotor, one placed in each phase while the primary winding is, of course, electrically insulated from the secondary.

## Polarity of Line Wires

By A. E. Christophersen

When installing electrical machinery it is often necessary to locate positive and negative sides of a circuit before a piece of apparatus can be connected. Therefore, a few simple methods for determining the polarity of line wires will be given.

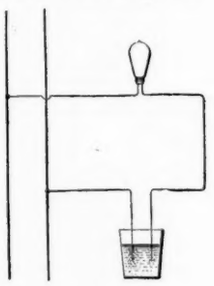


FIG. 1

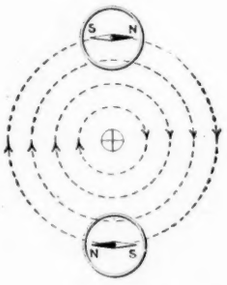



FIG. 2

FIG. 3

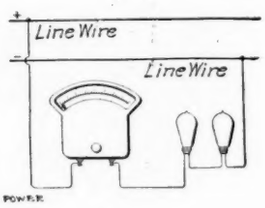



FIG. 4

Methods of Determining Polarity

A simple test is shown by Fig. 1, which represents the ends of two wires, one from each side of the circuit, placed about an inch apart in a glass of water. A suitable resistance, such as one or more lamps, should be in circuit. It is also well to reduce the resistance of the water by putting in a small quantity of salt. Bubbles of gas arise from each of the two terminals, but at a much greater rate from one than the other; that from which the least bubbles arise is the positive wire. It is not advisable to use this test on high potential circuits.

With the same apparatus a color test may be made. Instead of placing salt in the tumbler, throw in a few crystals of iodide of potassium and a small quantity of starch, then place the ends of the wire in the solution.

It will be found that the electrolyte turns to a dark blue color near the positive wire. If some of the prepared solution is poured on a piece of white blotting paper, and the wires are pressed against the paper, that part near the end of the positive wire will turn dark.

The compass test is based on the action of the magnetic lines set up around a wire carrying current on a magnet placed in the vicinity of the conductor. These magnetic lines are concentric with the conductor, their direction depending upon the direction of the current in the conductor. In Fig. 2 the conductor is represented perpendicular to the plane of the paper with the current flowing away from the reader. The direction of the magnetic lines is indicated by the arrow-heads. A compass needle placed in the magnetic field will tend to assume the position shown, its north pole pointing in the direction of the magnetic lines set up by the current in the conductor. If the current is in the opposite direction the lines of force will be in a counter clockwise direction, and the position of the needle will be reversed.

This test can also be made on a horizontal conductor. Select a part of the conductor that is placed or can be bent into an approximately north and south direction. Place the compass directly over the conductor, as indicated in Fig. 3. If the current in the conductor is flowing from south to north, the north pole of the compass will be deflected toward the east. If the current is flowing toward the south, the north pole of the compass needle will be deflected toward the west.

In order to obtain a proper deflection of the needle along the scale the positive ammeter lead must be connected to the positive side of the circuit, and the negative lead to the negative side of the circuit. If the connections are reversed the needle will be deflected in the opposite direction until its further progress is barred by a stop or by the side of the case. It is well in this test to use enough resistance in series with the ammeter so that the current through the instrument will be small. Allowing a large current to flow through the ammeter in the reverse direction may harm it by bending the needle. A small reading ammeter in series with a suitable resistance can be used in the manner illustrated in Fig. 4.

Voltmeters are sometimes used for testing the polarity of the wires, but it is not good practice as the needle is apt to be bent by the sudden rush of current in the reverse direction through the instrument coils if the connections are not properly made.

## What Would Happen to Alternator?

A plant consists of two power houses, one containing 6600-volt, three-phase, 60-cycle alternators driven by Pelton waterwheels, and the other a Parsons steam turbine driving a similar alternator of 500 kw. All the alternators are run in parallel, the total power of the water-driven units being about 800 kw. The steam-driven units are excited by a 20-kw., 120-volt, direct-current generator belt driven from a small steam engine.

Suppose the belt were to break when the engineer is in the boiler room so the excitation of the field coils of the steam-driven alternator stopped. Would the armature be damaged by the current from the other alternators?

G. Howe.

Brittania Beach, B. C., Canada.

# GAS POWER DEPARTMENT

## Oil for Internal-Combustion Engines

Some interesting data on the present oil situation are contained in the report of the "Prime Movers Committee" of the National Electric Light Association, submitted at its recent convention. Quoting from a bulletin of the U. S. Geological Survey, the report gives the production of oil in this country as compared with the rest of the world for the past four years, as follows:

PRODUCTION OF OIL IN BARRELS

| | 1909 | 1910 | 1911 | 1912 |
|---|---|---|---|---|
| East of the Rockies..... | 127,224,000 | 136,547,000 | 139,315,000 | 133,200,000 |
| West of the Rockies .... | 54,776,000 | 73,010,000 | 81,134,000 | 87,000,000 |
| Total in United States... | 182,000,000 | 209,557,000 | 220,449,000 | 220,200,000 |
| Estimated world production..... | 298,346,000 | 327,474,000 | 345,512,000 | 347,000,000 |
| Percentage of United States production to world production..... | 61.1 | 63.8 | 63.8 | 63.4 |

This shows that, although there was a decrease in the production east of the Rockies during 1912, this was compensated for by the increased production west of the Rockies, so that the total production in the United States during 1912 nearly equaled that of 1911.

In Europe the production has decreased, 60,000,000 bbl. being produced in Russia in 1912 as against more than 66,000,000 bl. in 1911. Roumania increased its product slightly but not sufficiently to offset the Russian decline. The world's consumption is approximately one million barrels a day.

Prices advanced steadily during 1912, the increase per barrel over those in 1911 in the various sections of the country being as follows:

| | |
|---|---|
| Pennsylvania | 70 c. increase |
| Illinois, Ohio, Indiana | 35 to 40 c. increase |
| Texas | 10 to 20 c. increase |
| California | 5 c. increase |

During the present year the prices have again advanced until now the Pennsylvania oils command a price nearly double that of a year ago.

The increased price of oil appears to have temporarily retarded the extension of the oil-engine business in the Eastern and Central states, although there are now in operation in this country over 300 installations of medium and heavy oil engines aggregating about 75,000 hp.

The report concludes with specifications for oil-engine fuels, abstracted from a paper by I. C. Allen, which was presented before the A. S. M. E. last winter. Mr. Allen's specifications were in part as follows:

*Fluidity*—Sluggish oils should be heated before being introduced into the engine. If it be necessary to use very heavy oils, the engine should first be warmed with a more fluid fuel, and the heavy oil introduced only after the engine is hot and running well. This process should be reversed when shutting down, and the heavy oils washed out of the engine valves and pipes with a lighter oil by running a short while on these lighter oils before allowing the engine to become cold.

*Tarrying Content*—An oil should contain not more than 4 per cent. of material insoluble in xylol, as a larger proportion of insoluble material will tend to form coke in the cylinders.

*Free Carbon*—There should be not more than a trace of free carbon in the oil, as this tends to stop the valves and carbonize on the surfaces of the cylinders.

*Volatility*—At least 80 per cent. should distill over at 350 deg. C. (662 deg. F.); greater than 20 per cent. residue at this temperature will show a large carbon content by coking.

*Flash Point*—The flash point should be between 60 and 100 deg. C. (140 and 212 deg. F.).

*Incinerating Oil*—In general, a heavy oil containing no flashy material should be enlivened by about 2 per cent. of a gas oil having a flash point 60 to 100 deg. C., or less, by mixing before introducing into the cylinders.

*Specific Gravity*—The specific gravity in itself, although of little significance, should not be greater than 0.920 (7.67 lb. per gal.); beyond this gravity the large proportion of heavy residual material would give trouble in the engine.

*Calorific Value*—This should not be less than 16,200 B.t.u. per pound, and the hydrogen content not less than 10 per cent., as lower values approach that of pure carbon and will give poor combustion.

*Sulphur Content*—The sulphur content should not be more than 0.75 per cent. Brass, zinc and copper are to be avoided in the surfaces exposed to combustion. Nickel-steel seems to be the best resistant material.

*Acidity and Alkalinity Content*—The oil should contain no free ammonia, alkalies or mineral acids, because of their pitting effect on the surfaces exposed to combustion.

*Ash Content*—The oil should contain not more than 0.05 per cent. of noncombustible mineral matter.

*Water Content*—A water content should not be greater than 1 per cent.

*Paraffin Content*—A paraffin content above 15 per cent. will give some trouble. A higher percentage of paraffin, because of the large quantity of oxygen necessary for complete combustion, will burn with difficulty.

*Alphaltum Content*—The heavy-oil engine, at least, as far as asphaltum oils are concerned, is still in its experimental stage, but it will not be unfair to assume that when the engineering difficulties are surmounted it will be practicable to burn any fuel oil containing asphaltum that is sufficiently fluid to flow, providing it be free from solid matter and water. An oil containing 21 per cent. asphaltum has been successfully burned.

### Lubricating Oil

*Viscosity*—The viscosity should be between 9 and 10 deg. (Engler) at 50 deg. C.

*Flash Point*—The flash point should be between 220 to 240 deg. C. (428 to 646 deg. F.).

*Carbonization*—When agitated with concentrated sulphuric acid the oil should not lose more than 10 per cent. by carbonization. This sulphuric-acid test gives an indication of the quantity of unsaturated hydrocarbons present.

*Solubility*—The oil should dissolve completely and clearly in benzine.

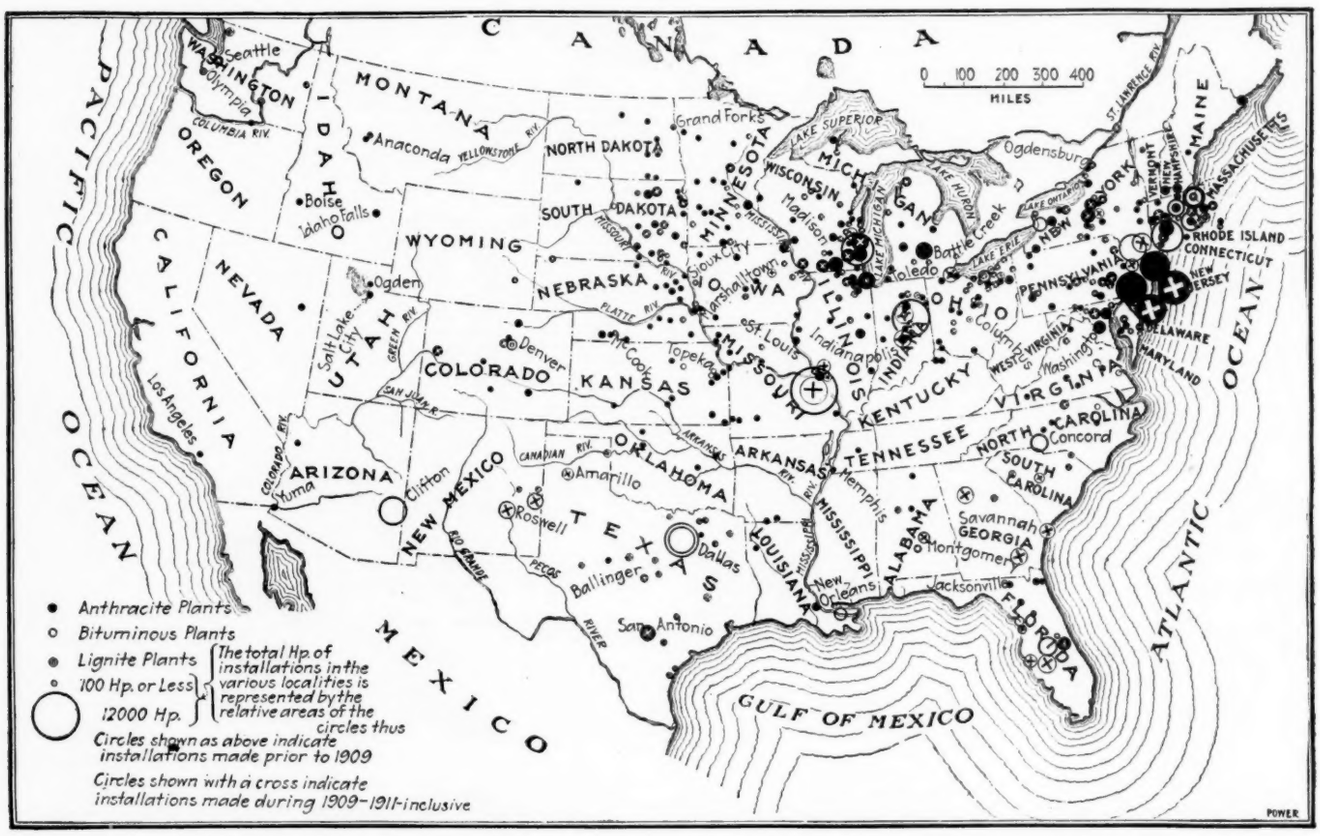
*Acidity*—It should be free from acids and alkalies, as these pit the cylinders, and free from resins and fats, as these saponify.

*Animal and Vegetable Oils*—Because of their tendency to decompose, animal and vegetable oils should not be used.

## Producer-Gas Situation in the United States

An impression seems to prevail in many circles that the gas-producer situation in this country is at a standstill. That such an idea is erroneous, however, is shown in a recent investigation by Prof. R. H. Fernald, for the Bureau of Mines, the results of which are published as Bulletin 55 of that department.

This shows that the number of producer-gas plants installed during the past three years amounts to 52 per cent. of the total number installed during the preceding nine years. This is exclusive of additions to existing plants during that period. Expressed in terms of power it means that the horsepower represented by the installation during the past three years amounts to 68 per cent. of the total horsepower installed during the preceding nine years. The distribution of gas-producer plants in the United States is shown on the map.




MAP SHOWING DISTRIBUTION OF GAS-PRODUCER PLANTS IN THE UNITED STATES

By 1912, however, these conditions appear to have been rectified to a large extent. Manufacturers have followed up and overcome many of the defects in design and salesmen are no longer making extravagant claims, but instead each individual case is now receiving the attention of the engineering department. In this connection it may be mentioned that it is no longer the tendency to overrate the capacities of producer plants, as was the custom a few years ago.

As regards labor, managers report less trouble from incompetent help than formerly. With special reference to bituminous producers the report says:

> The Government investigations at St. Louis and Norfolk demonstrated without question that both the updraft and the

In spite of this gratifying situation, a canvass of producer manufacturers revealed an attitude of uncertainty and expectancy; the first because of present oil-engine activities, and the second in the hope for a marked development in the bituminous gas producer. Owing to the increase in the price of oil and the difficulty in obtaining long-term oil contracts, however, the competition of the oil engine is not as keen as was at first expected.

Taking up the considerable number of unsuccessful, or only partly successful producer installations during the early period of this development, the report attributes these largely to three causes: First, there was too much theory and too little practical knowledge in the design of many of the early producers. Second, there was a scarcity of competent labor. Third, in a number of instances, salesmen totally unfamiliar with the requisites of a successful producer installation, had misled prospective customers in the belief that no matter what the customer required in the way of a power plant, a producer plant would give the best satisfaction. In consequence, many of the installations were unable to live up to the results guaranteed.

downdraft types will generate an excellent gas from bituminous coal, entirely suitable for commercial operation of gas engines.

There are, of course, inherent difficulties in each type, such as the mechanical extraction of the tar in the updraft producer, which reduces the efficiency of the plant and forces on the owner an undesirable byproduct, and the excessive labor in cleaning the downdraft system, the requirements of cleaning also prohibiting the continuous operation of a single generator unit. Undoubtedly, modifications will be made that will reduce these objections to a minimum, and other developments will gradually simplify such plants; but even as the plants exist today, the fact is that approximately 52 per cent. of the total producer-gas horsepower in this country is developed from bituminous coal and lignite.

The updraft producer for bituminous coal using a centrifugal scrubber, has been generally successful. From our knowledge of the double-zone producers, we believe that the question of the main filling with lamp black and soot is a very serious problem, far greater than the mechanical disposal of tar.

Bituminous producers in large units with proper auxiliarises are successful, but the small bituminous producers, owing to costs and difficulties of tar extraction are not as yet entirely successful.

The report concludes with some useful cost data on producer installations. These are in part included in the accompanying tables.

TABLE 1. COST OF PRODUCER-GAS ENGINES, 1912

| Horsepower | Cost F.O.B. Factory | Cost of Engine Erected Including Foundation | Cost per Horsepower F.O.B. Factory | Cost per Horsepower Erected Including Foundations |
|---|---|---|---|---|
| 45 | $1,950 | $2,400 | $43.30 | $53.30 |
| 50 | 2,000 | 2,500 | 40.00 | 50.00 |
| 50 | 2,200 | 2,500 | 44.00 | 50.00 |
| 55 | 2,250 | 2,700 | 40.90 | 49.10 |
| 75 | 3,300 | 3,850 | 44.00 | 51.30 |
| 100 | 3,850 | 4,475 | 38.50 | 44.75 |
| 100 | 4,000 | 4,400 | 40.00 | 44.00 |
| 100 | 4,000 | 4,600 | 40.00 | 46.00 |
| 125 | 4,500 | 5,150 | 36.10 | 41.30 |
| 150 | 5,800 | 6,670 | 38.70 | 44.50 |
| 165 | 6,800 | 7,550 | 41.20 | 45.80 |
| 180 | 6,500 | 7,500 | 36.10 | 41.70 |
| 190 | 8,500 | 9,250 | 44.75 | 48.70 |
| 200 | 7,000 | ..... | 35.00 | ..... |
| 200 | 7,800 | 8,970 | 39.00 | 44.85 |
| 200 | 8,500 | 9,500 | 42.50 | 47.50 |
| 200 | ..... | 9,700 | ..... | 48.50 |
| 250 | 8,500 | ..... | 34.00 | ..... |
| 250 | 9,200 | 10,500 | 36.80 | 42.00 |
| 250 | 10,600 | 11,600 | 42.40 | 46.40 |
| 300 | 10,200 | ..... | 34.00 | ..... |
| 300 | 11,500 | 13,125 | 38.30 | 43.75 |
| 300 | 11,800 | 12,900 | 39.30 | 43.00 |
| 300 | 12,500 | 13,500 | 41.70 | 45.00 |
| 500 | 16,000 | 18,000 | 32.00 | 36.00 |
| 500 | 17,000 | ..... | 34.00 | ..... |
| 500 | 20,000 | 22,500 | 40.00 | 45.00 |
| 1000 | 31,000 | 35,000 | 31.00 | 35.00 |
| 1000 | 34,000 | ..... | 34.00 | ..... |
| 1000 | 35,000 | 39,000 | 35.00 | 39.00 |
| 3000 | 90,000 | 101,500 | 30.00 | 38.85 |

TABLE 2. COST OF GAS PRODUCERS, 1912

| Horsepower | Cost F.O.B. Factory | Cost Erected Including Foundation | Cost per Horsepower F.O.B. Factory | Cost per Horsepower Erected Including Foundation |
|---|---|---|---|---|
| 15 | $396 | ..... | $26.40 | ..... |
| 15 | 450 | $500 | 30.00 | $33.35 |
| 25 | 455 | ..... | 18.20 | ..... |
| 25 | 560 | 625 | 22.40 | 25.00 |
| 35 | 560 | ..... | 16.00 | ..... |
| 50 | 700 | ..... | 14.00 | ..... |
| 50 | 730 | 820 | 14.60 | 16.40 |
| 50 | 900 | 1,035 | 18.00 | 20.70 |
| 50 | 1,400 | 1,800 | 28.00 | 36.00 |
| 75 | 910 | ..... | 12.15 | ..... |
| 75 | 940 | 1,050 | 12.50 | 14.00 |
| 100 | 1,050 | ..... | 10.50 | ..... |
| 100 | 1,100 | 1,230 | 11.00 | 12.30 |
| 100 | 1,200 | 1,380 | 12.00 | 13.80 |
| 100 | 1,450 | 1,850 | 14.50 | 18.50 |
| 100 | ..... | 2,400 | ..... | 24.00 |
| 150 | 1,295 | ..... | 8.65 | ..... |
| 150 | 1,530 | 1,710 | 10.20 | 11.40 |
| 150 | 1,600 | 1,840 | 10.65 | 12.30 |
| 150 | ..... | 3,300 | ..... | 22.00 |
| 200 | 1,725 | ..... | 11.50 | ..... |
| 200 | 2,050 | 2,300 | 10.25 | 11.50 |
| 200 | 2,200 | 2,750 | 11.00 | 13.75 |
| 200 | 2,800 | 3,220 | 14.00 | 16.10 |
| 200 | 3,000 | 3,700 | 15.00 | 18.50 |
| 200 | ..... | 4,000 | ..... | 20.00 |
| 250 | 2,100 | ..... | 8.40 | ..... |
| 250 | 2,600 | 2,900 | 10.40 | 11.60 |
| 250 | 3,500 | 4,300 | 14.00 | 17.20 |
| 250 | ..... | 4,750 | ..... | 19.00 |
| 300 | 2,700 | 3,500 | 9.00 | 11.65 |
| 300 | 3,200 | 3,600 | 10.65 | 12.00 |
| 300 | 3,400 | 3,910 | 11.35 | 13.05 |
| 300 | ..... | 5,700 | ..... | 19.00 |
| 500 | 6,000 | 7,000 | 12.00 | 14.00 |
| 500 | 8,500 | 10,000 | 17.00 | 20.00 |
| 500 | ..... | 9,400 | ..... | 18.80 |
| 1000 | 12,000 | 13,500 | 12.00 | 13.50 |
| a1000 | 14,500 | 17,000 | 14.50 | 17.00 |
| 1000 | ..... | 18,700 | ..... | 18.70 |
| a3000 | 40,000 | 44,000 | 13.25 | 14.65 |

TABLE 3. COST OF PRODUCER-GAS INSTALLATIONS, 1912

| Horse-power | Cost of Gas Producer and Engine Erected Including Foundations | Cost of Complete Plant, Exclusive of Buildings* | Cost of Complete Plant Including Buildings* | Cost per Horsepower Gas Producer and Engine Erected Including Foundations | Cost per Horsepower Complete Plant Exclusive of Buildings* | Cost per Horsepower Complete Plant Including Buildings |
|---|---|---|---|---|---|---|
| 50 | $4,300 | $5,300 | ..... | $86.00 | $106.00 | ..... |
| 100 | 6,250 | 7,800 | $9,100 | 62.50 | 78.00 | $91.00 |
| 100 | 12,400 | 15,800 | 17,500 | 62.00 | 79.00 | 87.50 |
| 200 | 13,200 | 16,200 | ..... | 66.00 | 81.00 | ..... |
| 250 | 14,800 | 18,200 | ..... | 58.20 | 72.80 | ..... |
| 300 | 17,000 | 22,000 | 23,800 | 56.65 | 73.35 | 79.35 |
| 500 | 25,000 | 29,500 | ..... | 50.00 | 59.00 | ..... |
| 500 | 32,500 | 47,500 | ..... | 65.00 | 95.00 | ..... |
| 1000 | 48,500 | 57,500 | ..... | 48.50 | 57.50 | ..... |
| 1000 | 56,000 | 84,000 | ..... | 56.00 | 84.00 | ..... |
| 3000 | 145,500 | 202,000 | ..... | 48.50 | 67.35 | ..... |

*This includes producer, engine, electric generator, piping, switchboard and auxiliaries, all erected with suitable foundations.

## Canada's Largest Power Station

Work has been started on the hydro-electric power station of the Cedar Rapids Manufacturing & Power Co., Montreal, Que., which, when completed, will be the largest in the Dominion of Canada. Its initial rating will be about 100,000 hp., and later on this will be increased to 160,000 hp. The site is at Cedar Rapids, in the St. Lawrence River, about 30 miles above Montreal.

The plant will be 663 ft. long and 130 ft. wide and will be built as a part of the dam. The intakes will be of the scroll or involute type. Orders have been placed by the Cedar Rapids company for the generating equipment. This includes twelve 10,800-hp. waterwheels, which are to operate at 56 r.p.m. under a head of 30 ft., and will be the largest ever built. There will also be three 1500-hp. exciter units which will operate under the same head at 150 r.p.m. Twelve generators are to be connected to the waterwheels.

The design of the turbines will be very much the same as that of the wheels for the plant of the Mississippi River Power Co., at Keokuk, Iowa. The chief difference will be in arranging for carrying the weight of the generator rotor and the moving parts of the turbine on a thrust bearing above the generator instead of below, as is done with the Keokuk turbines. The waterwheel contract includes the turbine complete, the shaft running through the turbine and generator, the thrust-bearing support or truss to be located above the generator, also the thrust bearing complete. The weight of the generator will be taken through cast-iron supporting barrels through the turbine to the foundation below. The main units will be of the single-runner vertical-shaft type and will be installed in wheel chambers of spiral shape formed in the concrete foundations of the power house. The exciters will be of the same type but smaller in size. The runners for these wheels will be an enlargement of a model runner which under test at Holyoke gave an efficiency of 90 per cent.

About 100,000 yd. of concrete work and 2,000,000 yd. of rock and earth excavating will be necessary. Contracts for 80,000 hp. of the output of this station have already been closed. Of this, the Aluminum Co. of America will take 60,000 hp. and the Montreal Light, Heat & Power Co. will take 20,000 hp. It is expected that the plant will be finished in October, 1914.

# HEATING AND VENTILATION

## Steam and Electric Load Curves in Large Buildings

The relation between the steam requirements for heating and electric loads in large buildings is a question upon which very little accurate data are available. This year the committee on heating of the National Electric Light Association collected a number of curves typical of different types of building and presented some of them in the report. This interesting collection of curves is reproduced herewith.

The charts include curves showing the steam requirements of the building and curves showing the steam which would be required for the electricity actually consumed, based on a factor of 60 lb. per kw.-hr. In the case of some buildings where pumps or steam-driven elevators are installed, there is an additional curve showing the high-pressure steam required for these pumps, and a curve showing the total steam which would be available for exhaust from both the pumps and electric units, if they were installed. The curves show the actual steam required, and in the case of the curve showing steam available for exhaust, a slight deduction should be made on account of the condensation removed by steam and oil separators.

Fig. 1 shows the steam and electrical requirements of a department store in Detroit on a typical winter day. This store is a brick building of five stories, having cubical contents of 1,545,000 cu.ft. and a connected steam radiation of over 10,000 sq.ft. There are also installed in the store a duplex steam pump, 18x12 in., and a house pump, 12¼x10 in. The store is open for business from 8 a.m. until 5:30 p.m.

Fig. 2 represents the steam and electrical requirements during a summer day of a large department store in Chicago. This building is eight stories in height and the cubical contents are approximately 7,800,000 cu.ft. In addition to radiation for both direct- and indirect-steam heating, there is required steam for 16 elevators and for boiler-feed pumps. Fig. 3 shows the steam and electrical requirements in the same department store during the holiday trade, in ordinary winter weather, and Fig. 4 during severe winter weather.

Fig. 5 shows the steam and electrical requirements in an office building in Detroit. This is an 8-story building of brick construction having cubical contents of 565,000 cu.ft. and connected steam radiation of 6600 sq.ft.

Fig. 6 shows the steam and electrical load in an office building in New York. This is a 24-story building, having cubical contents of 6,500,000 cu.ft. and having 63,140 sq.ft. of radiation connected. This is a composite curve averaging 28 typical winter days.

Fig. 7 shows a large office building in St. Paul. This is a steel and brick building, 16 stories high, having cubical contents of 1,907,800 cu.ft. and connected steam radiation of 19,500 sq.ft. This diagram shows conditions on a typical winter day in St. Paul. Steam is kept on all night in cold weather, thus giving a more even steam line than for some of the buildings.

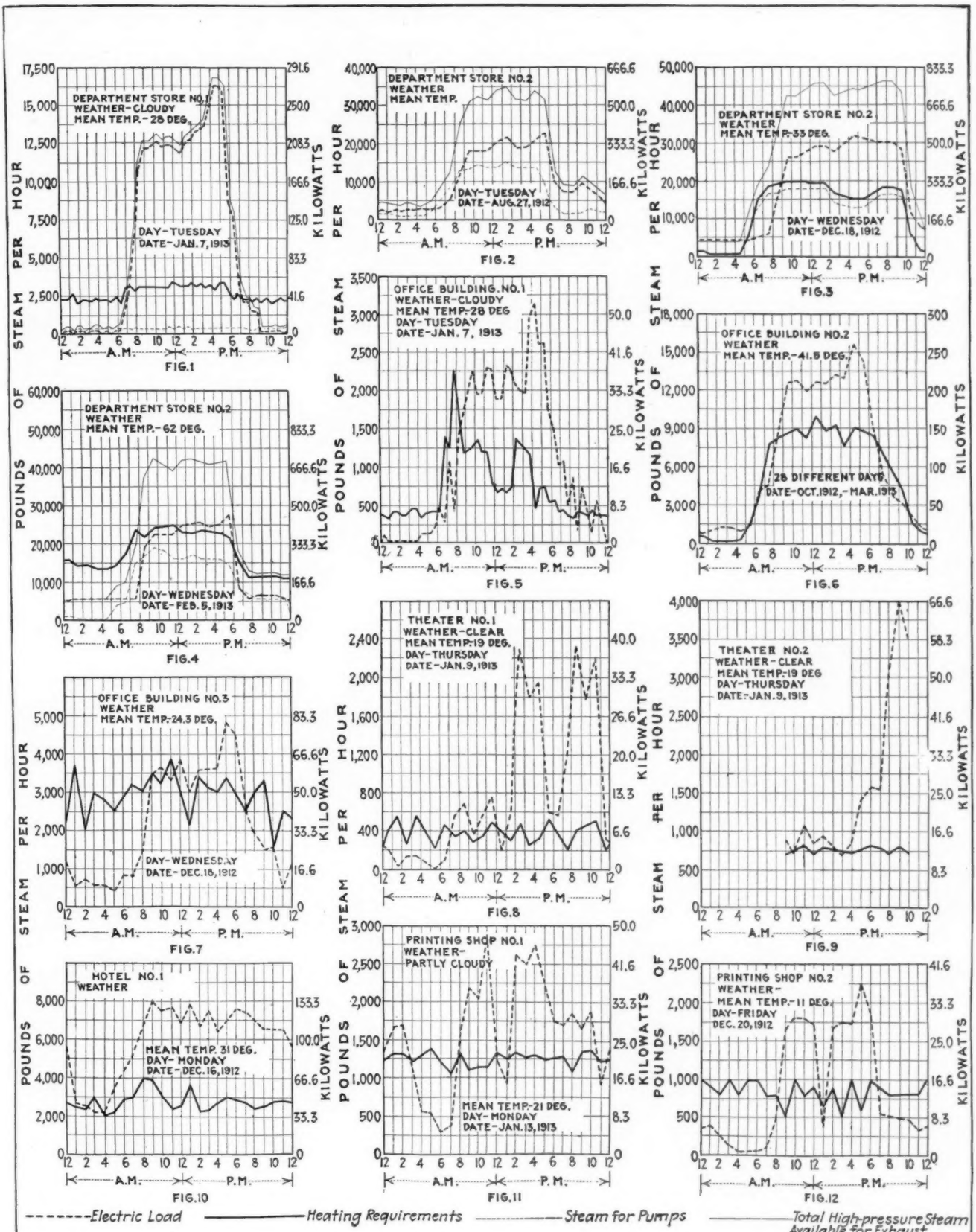
Fig. 8 represents the steam and electrical requirements in a theater in Detroit. This is a five-story building of brick construction, having cubical contents of 710,000 cu.ft. The steam for the office portion of this building, however, is not shown in the diagram, simply the steam and electrical requirements in the theater. This curve shows that there are two performances each day in the theater. Fig. 9 is a diagram for another Detroit theater. This building is brick, with a stone front, having cubical contents of 750,000 cu.ft. The steam for the office building is not shown in the diagram. Fig. 10 shows the steam and electrical requirements of a large hotel in St. Paul, on a typical winter day. This is a 12-story building, of tile and steel construction, having cubical contents of 2,308,270 cu.ft. The heating load in this building is fairly uniform and the steam required for the electrical load is not only variable, but runs far in excess of the steam used for heating.

Fig. 11 shows the steam and electrical requirements in a printing shop in Detroit. This is a five-story brick building, having cubical contents of 315,000 cu.ft. and a connected steam radiation of 4008 sq.ft. The hours for this shop are 7:30 a.m. to 5:15 p.m. There is also a night shift with regular hours.

Fig. 12 represents a printing shop in St. Paul. It is a four-story brick building, having cubical contents of 695,320 cu.ft. and connected radiation of 9529 sq.ft. This is a publishing and printing house, and the hours for the night shift are irregular. It will be noticed that the electrical load is used principally in the daytime.

Comments on the charts follow to the effect that even in the winter time, when the heating and power requirements more nearly approach each other, there is still a wide variation in the two curves, some showing that at certain periods of the day the demand for steam for heating is in excess of the demand for electricity, while at other periods of the day the demand for electricity is greater than the demand for heating. In view of the fact that the steam demand for heating disappears altogether in the summer, and in the winter is not coincident with the demand for electricity, the utilization of exhaust steam for heating in isolated plants, in the opinion of the committee, is not nearly as great a factor in economy as has sometimes been claimed. The question is not whether heating can be done economically with exhaust steam, but whether the entire plant can be operated economically. In the most modern buildings the heating load constitutes a comparatively small part of the total requirements of the building.

When the electric load for the year is considered it will be seen that an isolated plant produces a large amount of steam for electrical energy uneconomically in order to make a comparatively small economy in steam heating. In other words, in attempting to secure a small economy, a greater economy is lost sight of.




STEAM AND ELECTRIC LOAD CURVES FOR VARIOUS TYPES OF BUILDINGS

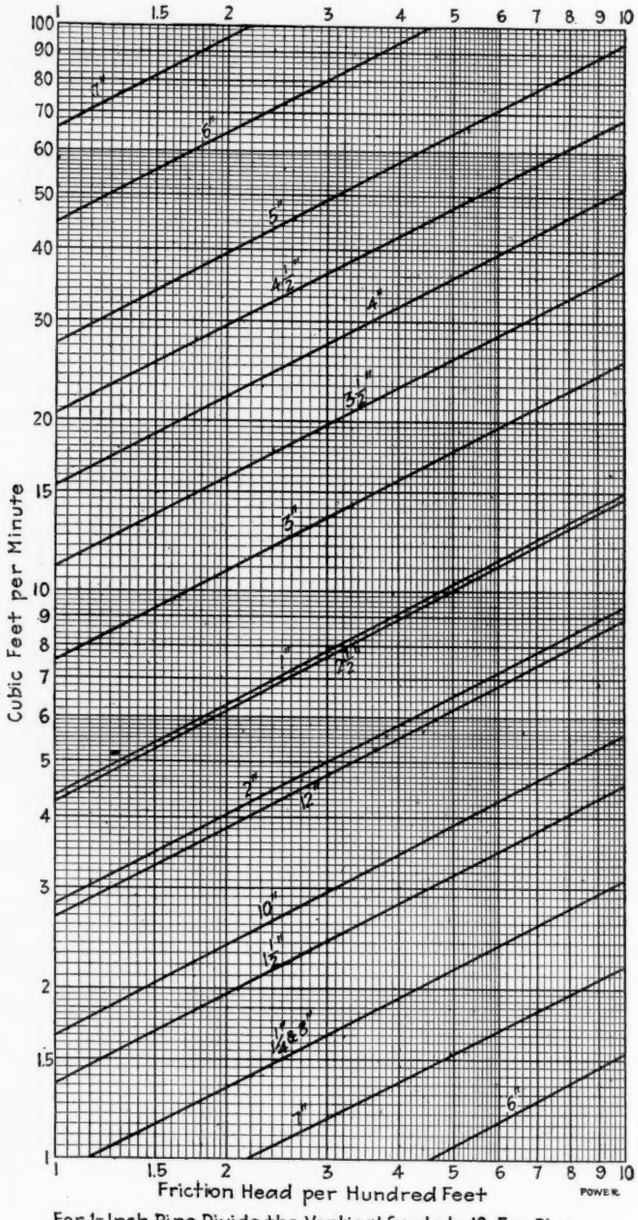
POWER

# Flow of Water in Pipes

By W. L. Durand

In problems relating to the flow of water through pipes there are five variables which must be considered. These are: Quantity of water, size of pipe, velocity of flow, length of pipe, friction head.

The last two may be reduced to one variable "friction head per unit length," such as "per hundred feet."


Cubic Feet per Minute
Friction Head per Hundred Feet
POWER
For 1-Inch Pipe Divide the Vertical Scale by 10. For Pipes 6 to 12-Inches in Diameter Multiply the Vertical Scale by 100

Quantity of Water, Friction Head and Size of Pipe

In the July 9, 1912, issue, Mr. Evans gives a list of the best known formulas for the flow of water in pipes. He also gives a table of friction heads and velocities with values derived from each of the formulas for the different commercial sizes of pipe. Based on the average of these values the writer made a set of curves on logarithmic paper which was published in the Oct. 29, 1912, issue. Using these curves I have worked up a second set of curves between quantity of water, friction head and size of pipe. These are presented in the accompanying chart.

Any equation of the form $y = bx^n$ may be plotted as a straight line on logarithmic paper, and *vice versa* any straight line on logarithmic paper may be reduced to the form $y = bx^n$. It is also possible to reduce a set of curves between three variables, which are straight lines on logarithmic paper, to the form $y = bx^n z^m$.

Without going into the method employed the accompanying curves reduce to

$$V = 0.4\, d^{2.64} h^{0.53}$$

From this formula the following formulas may be derived, by the use of which any one of the four variables mentioned above may be found if any other two are known.

$$V = 0.327\, d^2 v$$

$$v = 1.22\, d^{0.64} h^{0.53}$$

$$v = 3.06\, \frac{V}{d^2}$$

$$h = \frac{5.6\, V^{1.89}}{d^5}$$

$$h = \frac{0.69\, v^{1.89}}{d^{1.21}}$$

$$d = \frac{1.42\, V^{0.38}}{h^{0.2}}$$

$$d = \frac{0.73\, v^{1.56}}{h^{0.83}}$$

in which,

$V$ = Cubic feet per minute;
$v$ = Velocity in feet per second;
$h$ = Friction head in feet per 100 ft.;
$d$ = Actual internal diameter of pipe in inches.

From the first formula it is also possible to make an equalization table similar to that in use for steam pipes. In using such a table the quantity of water and friction head per unit length are constants and the diameter is the only variable. If, then, in the formula

$$V = 0.4\, d^{2.64} h^{0.53}$$

$V$ and $h$ are taken as constants, and $d$ as a variable, all that is necessary to make this table is to take the actual diameters and raise them to the 2.64 power. This table is as follows:

| Dia., In. | Equalization Factor |
|---|---|
| 1 | 1.13 |
| 1¼ | 2.34 |
| 1½ | 3.52 |
| 2 | 6.80 |
| 2½ | 10.86 |
| 3 | 19.3 |
| 3½ | 28.3 |
| 4 | 39.5 |
| 4½ | 53.3 |
| 5 | 71.7 |
| 6 | 116 |
| 7 | 172 |
| 8 | 240 |
| 10 | 440 |
| 12 | 700 |

By the use of this table the size of pipe equal to several smaller pipes may be determined so that the friction loss per unit length will be the same in all.

What size pipe should be used to feed four 3½-in. pipes? From the table, 28.3 is given as the equalization factor for 3½-in. pipe. Then

$$4 \times 28.3 = 113.2$$

The nearest size pipe to this factor is 6 in., which will feed four 3½-in. pipes with the same friction loss in all.

# EDITORIALS

## Educational Work in Summer

Now that the summer is here, the educational work so vigorously carried on by many engineering organizations during the winter will be discontinued. The number in attendance at the meetings will consequently decrease and interest in the organizations will, in a measure, be weakened.

In the sultry evenings of summer a trip to the beach, a trolley ride or the hammock in the yard—if one is so fortunate—are all more desirable than the smoke-laden atmosphere of the usual illy ventilated meeting room. Discussion of troubles or of the questions asked on the floor should not cease. Power plants have their summer troubles, although they are not usually so numerous as in winter; nevertheless, there is always a variety of subjects, discussion of which is beneficial.

Above all, do not wait until late in the fall to appoint educational committees. Appoint them now so that a thorough educational campaign may be prepared and ready to produce good results as soon as the season opens in the fall.

❋

## Care of Boiler-Furnace Breechings

Some engineers regard the breeching or flues of boiler furnaces as little more than a sewer for carrying away the waste products of combustion, which, if allowed to get into the room, would pollute the atmosphere.

Breechings do not require much attention normally and it is because of this, perhaps, that they do not receive attention when they are much in need of it. The effective area of opening in most breechings is none too large even when the breeching is clean. When the breeching, flues and setting are allowed to accumulate soot the draft is not only impaired, but may become inadequate to meet heavy loads. If forced draft is used and a condition of soot accumulation exists and the settings, flues, etc., leak, the pressure within will force the gases into the room. If this leakage of gas becomes chronic and the damper regulators are known to be working well, it indicates obstructed flues and breechings.

Instances where natural draft has displaced forced draft and one or more boilers have been cut out of service after the breechings have been properly cleaned are not unknown.

Where natural draft prevails and the boilers are working hard, steps should be taken to stop leaks in the breeching. A leaky breeching containing much soot may give enough draft while the fuel bed is thin and the load about normal, but with a thick fuel bed and sudden demands for steam, serious trouble is likely to be experienced.

Cleanliness is admirable, but if as much attention were given to cleaning boiler settings, flues, tubes, etc., as is given to rubbing alcohol on a marble switchboard or polish on brass rails, the coal bill might be materially reduced in many plants.

## On the Wrong Tack

When discussing the disadvantages of an isolated plant, advocates of the central station are prone to minimize the question of heating. Considering the fact that this is one of the factors which has deprived them of a great deal of business it is not surprising that their interests rather than an unbiased engineering analysis should dictate their viewpoint.

On other pages of this issue appear a number of charts, showing the steam required for electric and heating loads in different types of building, as prepared by the committee on steam heating of the National Electric Light Association. High-speed automatic engines using sixty pounds of steam per kilowatt-hour were taken as a basis and it was shown that the steam required to generate the electrical load was considerably in excess of the amount needed for heating. The two loads were not coincident, and, in short, using exhaust steam for heating under the circumstances mentioned, was an attempt to secure a small economy by losing sight of a greater economy, the greater economy meaning, we take it—central-station current and separate steam service.

No doubt there are a great many small noncondensing plants in which the steam consumption runs well up to sixty pounds per kilowatt-hour, but with a rate from the central station which should include a percentage for large overhead charges and some addition for profit, and considering the extra cost of heating, even these plants should make a favorable showing. When exhaust steam from an engine is used for heating about eighty-five per cent. of the initial energy is available, so that if the power load is in excess there is no need for a separate source of supply. Good practice would be to lower the steam rate on the power load, as there is no real occasion for discharging so much excess steam to atmosphere.

Without condensers, a compound engine, or a single-cylinder, four-valve unit would reduce the steam consumption by 30 to 40 per cent., and in most cases there would still be enough steam for heating. A further reduction in steam rate would be possible by installing a condenser, which would carry the summer load and the excess of power over heating.

The argument against a condenser in an office building is "cooling water." Water at high cost would, of course, soon counterbalance the efficiency added by the condenser. It would then be necessary to turn to the cooling tower, and, although the use of this apparatus is not common in office-building plants, there are types which will give satisfactory service at a cost of about one pound of water for every pound of steam condensed. The amount of water used, due to the lower steam rate, would then be lower than in noncondensing plants of the best type, and the excessive use of water for cooling would be obviated.

There is the possibility of using hot-water heat and operating condensing even on that part of the load supplying the heating. The vacuum in the condenser can be regulated to suit the temperature of water required, or

the load can be shifted from the unit carrying the heating to the unit running full condensing, or *vice versa,* so that the required amount of steam can be obtained to give almost any temperature of water. The head in unusually high buildings might require a division of the system into sections, but in the ordinary building there would be no difficulty in operating a hot-water system.

The additional first cost of the refinements just mentioned would prohibit their use in plants under, say, two to three hundred horsepower. For larger plants a thorough investigation would be worth while before a decision is made on the equipment of the plant.

These are a few of the arguments that the heating committee might have included in their report had they any intention of treating the subject fairly. If continued confidence in their analyses is expected, a change in methods is necessary. A fair and equal presentation of the facts for both sides is all that is asked, and generally this would be enough to swing the pendulum toward the isolated plant. In engineering discussions there is no room for commercial quibbling, for any omissions or deductions unfair to one side tend to act as a boomerang discrediting those participating.

## Graphite in Boilers

POWER has printed considerable in the last year on the use of graphite in boilers to remove or prevent scale. Most of this was given in the form of letters from readers telling their own experience and all of these letters confirmed the efficacy of the treatment. Then came the announcement in a paper by Lieut.-Com. Frank Lyon, U. S. N., before the American Society of Naval Engineers, that graphite in boilers accelerated corrosion and was, therefore, to be classed with "Dangerous Compounds." This seemed too important a criticism to be ignored, and it was decided that before more was printed on the subject all effort should be made to uncover the real facts.

A number of manufacturers of boiler graphite were written to and all maintained that there was no truth in Lieutenant Lyon's contention. All but one of them had evidence to offer and that one dismissed the question as too ridiculous for serious consideration. The most thorough refutation so far presented is the report, printed on page 37.

Another manufacturer also reported on an investigation of a marine boiler that was supposed to have been injured by the use of graphite. Pitting developed after removing the zinc, which had been in the boilers to prevent corrosion. Because graphite was being used, it was charged that the corrosion was due to it. The report affirms that pitting would have resulted without the graphite, and there seems no reason to question this. Corrosive agents in the feed water would do the mischief.

At the recent meeting of the International Railway Fuel Association the question came up and the following, quoted from the *Railway Age Gazette,* is also reassuring:

> **The use of pure amorphous graphite was strongly recommended as it is purely mechanical in its action, having a tendency to break off the scale as well as preventing its formation. A simple laboratory experiment was made by applying this grade of graphite to one side of a plate and intermittently boiling. After 80 hours, extending over a period of 10 days, the graphite was still as active in its protection of the plate as it was originally. The opposite side of the plate was rusty.**

Apparently the sum and substance of the situation is that graphite, at least in the proportions in which it is used in boilers, has no effect, so far as corrosion is concerned, either to cause it or to prevent it (unless it thoroughly coats the metal) and is to be regarded as simply inert except as a scale remover. In that capacity its action seems to be purely mechanical and not chemical.

## Rate Decisions

The excellent work which the New York Public Service Commission of the second district has accomplished under the able chairmanship of F. W. Stevens, whose term has just expired, is again brought to our attention in the recent ruling in the Buffalo rate case. In fixing the rate schedule the commission acted upon the theory that the stockholders were entitled to a reasonable return upon the actual investment, but that the public should not be made to pay a return upon factitious intangibles. Wherever a difference arose as to the physical value of any property the commission, in every instance, gave the company the benefit of the doubt, but it was firm in refusing to permit such items as franchise, "going concern value" and certain alleged contracts to be considered as part of the capital stock upon which a return should be made. Moreover, reference to page 39 of this issue will show that the rate differential is based largely upon the connected load, a point that meets one of the usual central-station contentions.

Comparison with the present New York Edison rates shows that the people of New York pay from one and one-half to over three times as much for electric energy as do the people of Buffalo, the greatest hardship coming upon large residences and storekeepers.

Hearings in the rate case against the New York Edison Co. have been dragging on before the Public Service Commision of the first district for the past two years. This delay has been occasioned to some extent by the pressure of subway matters, which occupied a large part of the commission's time last year. Now that these have been disposed of, it is only reasonable to expect that the decision in the Edison case will be hastened. If the commission has ever felt any doubt as to its power to prescribe rates, the precedent established by the up-state commission should now pave the way.

The Christie air-steam engine is again in evidence. The Clinton (Iowa) *Herald* of June 1, prints a three-column advertisement in the form of an article, illustrated with a picture of one of these engines, weighing 46,500 lb., which will be installed about July 1 at the Clinton Paper Co.'s mill. The article winds up with the usual allusion to the present opportunity to obtain stock under especially favorable conditions. Before investing money in it, we should recommend reading the files of POWER as follows:

| | |
|---|---|
| Christie air-steam engine, p. 382 | Sept. 5, 1911 |
| Discussion letters on same, p. 528 | Oct. 3, 1911 |
| p. 934 | Dec. 19, 1911 |
| p. 166 | Jan. 30, 1912 |
| p. 483 | Apr. 2, 1912 |
| Christie air-steam engine, by John T. Christie, p. 609 | Oct. 17, 1911 |
| Editorial, p. 603 | Oct. 17, 1911 |
| Performance of the field engine, by L. B. Lent, p. 721 | Nov. 7, 1911 |

Who said the gas-engine business was moribund? The C. & G. Cooper Co., of Mt. Vernon, Ohio, have twenty orders now in the shop, and others offering if they could promise delivery.

# READERS WITH SOMETHING TO SAY

## Correct Position of Gate Valves in Horizontal Steam Lines

I would be pleased to be advised by readers as to the proper position for gate valves in large horizontal steam lines. There seems to be a difference of opinion on this point, although the general practice in this locality is to place the valve with the stem horizontal.

Experience here indicates that when a globe valve is so located that no condensation can accumulate above it, and it never changes temperature under pressure, the pressure should be on the under side of the disk. If the valve is in an undrained vertical pipe in a steam hose or flue blower, tank heater, or similar position so that condensation can accumulate and cool above the valve, it should be piped with pressure on top of the disk. This will avoid cutting out the disk and seat, due to the valve shrinking open when it cools. Obviously there should be a cutoff valve where the branch comes off, which can be closed to pack the globe valve.

D. L. Bellinger.

Glens Falls, N. Y.

## Curves Showing Year's Output of Plant

The accompanying graph, compiled for the year of 1912, shows the operation of a 300-hp. power station furnishing heat, light, power and compressed air. The direction of the wind, velocity and temperature were obtained from the weather bureau and the graph shows

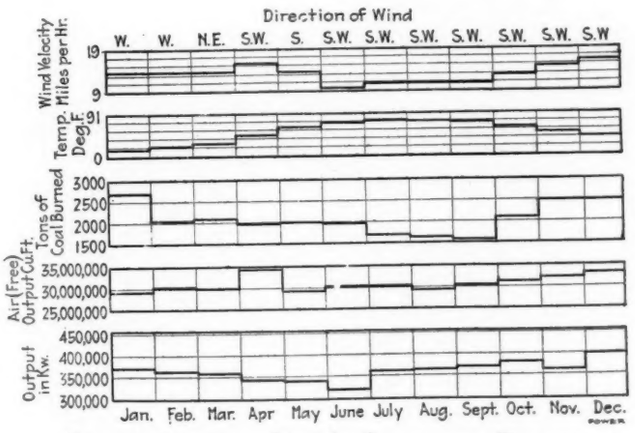



Chart Covering Year's Output of Plant

in a marked degree the influence of these three factors on the consumption of coal.

It should be noted that in the month of March, the electrical output decreased while the coal consumption increased. The temperature increased but the general direction of the wind was northeast. North and northwest winds affect the radiation from the building materially. This accounts for the increase in coal consumption at this time.

The sudden increase in kilowatt output for July is due to the increased amount of current necessary to operate the ventilating fans at high speed. The drop in output for November shows that these fans were slowed down to a speed necessary to give the proper ventilation for the heating season. On account of mechanical troubles with the cooling tower it was not possible to keep the exhaust turbine in continuous operation until the first part of July. It was kept in continuous service from that time until the first of October. During these three months, it will be noted, the coal consumption gradually decreased until Oct. 1, when the turbine was shut down and exhaust steam was turned into the heating system. At this point the wind velocity gradually increased and the temperature decreased.

F. J. Ravlin.

Chicago, Ill.

## Shaft-Aligning Troubles as Infuenced by Belts

There have been a few articles published with regard to shaft aligning with the new patented instruments. These articles have mentioned the great saving made, but have not given any specific figures. I have been doing some of this work and have discovered several points not brought out in any article I have read.

A line of shafting, motor driven, was picked out and ammeter and voltmeter readings taken. The shaft was then aligned and found to be both out of line and out of level. After aligning, readings were again taken and a large reduction in friction looked for. Instead we found considerable more friction than before the shafting was touched. A close examination showed that the shaft, where it had been out of line, was always in the direction of belt pull to the countershafts. Where the shaft was lined up it tightened all the belts and the extra friction due to tight belts was more than was gained by the straight shafting.

Of course, the proper way would be to lengthen the belts to the same tension they had before the shaft was aligned. But just how is this to be accomplished? A test could, of course, be made without belts, but this hardly meets running conditions. In our case the belts were not tightened sufficiently to warrant putting in a new piece and yet they were tightened enough to neutralize the good work of the instrument. Until we have a reliable instrument for measuring belt tensions, a test of this nature will at least be open to question.

The experiment also demonstrated the fact that, although there is probably a large loss through line shafts out of line, there is probably a greater loss through belts unnecessarily tight. The trouble is, of course, with the man who does the lacing. A belt begins to slip and this man is called on. Instead of taking up just enough

to carry the machine nicely he takes up all he can get, probably with the idea that it will be a longer time before he is again called on. This, of course, results in stretching the life out of the belt and increasing the friction load on the engine.

When aligning shafting having old-style hangers which are not adjustable, except by shimming, at least six men should be on the job if the work is to be quickly done, as one man at the instrument can take care of that many working on the hangers.

Work in a gallery must generally be done when everything else is shut down, as the vibration so affects the instrument that it is impossible to work at all closely.

This letter may seem to indicate lack of faith in the shaft-aligning instrument, on the part of the writer, but such is not the case. The instrument will prove both a time and money saver where considerable shafting is to be cared for. In order to show results, however, it will be necessary to get after the belt lacer as well as the person directly responsible for the badly aligned shafting.

JOHN BAILEY.

Milwaukee, Wis.

## Guide Point for Boiler Tubes

When it is necessary to remove a tube in the third or fourth row from the bottom it is generally cut free at each end and pushed or drawn out through the front header, quite a laborious job. The tubes are usually covered with ashes or soot scale, which must be removed

FIG. 1. CONE-SHAPED PLUG

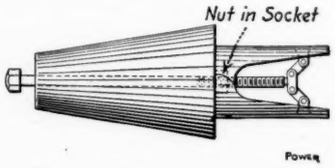



FIG. 2. POINT WITH LINK ATTACHMENT

before the tube can be drawn through the tube hole. When putting in new tubes there is trouble of a different character.

In most all horizontal water-tube boilers there are vertical brick baffle walls to direct the gases across the tubes several times before they reach the uptake. These baffles are easy to assemble while erecting the boiler and will last many years under ordinary conditions. Some of the baffles are of a special form of firebrick, placed between the tubes, but often have a bar across the back to keep them in place. Others are held in place by special shaped iron plates, which are afterward covered with about 2 in. of plastic asbestos to protect them from the fire.

Now these plates and firebrick fit snugly about the tubes and are frequently loose enough to drop down ¼ in. into the opening from which the tube was drawn. It requires patience to push the tube through the opening, even though it were ⅛ in. larger than the tube, but to have the plates or firebrick come down and partially close the opening, and with no other means than a long bar to remove them requires time and labor. Many tubes have been so badly battered on both ends by driving on them in an effort to break the firebrick obstruction that they were unfit for use after they had been driven into place.

To overcome this difficulty a cone-shaped plug, Fig 1, was made to fit in the end of the tube. This did very well, but frequently got stuck between the firebrick and considerable trouble was encountered in removing it.

Next an iron point was made partly hollow, for lightness, with long prongs, to extend back into the tube. Between these prongs a pair of links, attached to the end of a bolt, were fitted, which extended from the point through a nut fitted into a socket between the horns, as shown in Fig. 2. By tightening the bolt, the prongs are made to tightly grip the inside of the tube, which prevents the device from drawing out of the tube end if it is necessary to withdraw the tube after it has once been entered.

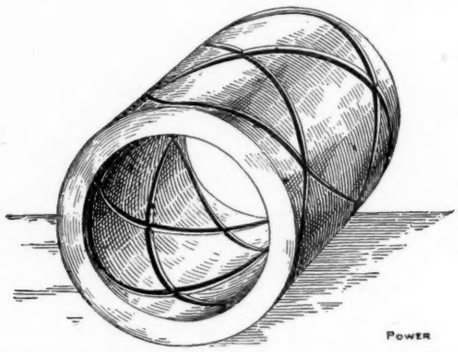
As the point is made of iron it will not give or become battered by the brick or jagged edges of the iron baffle-plates, and being wedge-shaped will, with light driving, force the baffles back and allow the tube to pass between them. When the tube is in place the bolt is slackened and the point removed from the tube. The largest diameter of the point is such as to pass through the hole in the header and to protect the end of the tube from being bent or battered. A patent has been applied for.

R. A. CULTRA.

Cambridge, Mass.

## Revolving Sleeve for Bearings

Recently I made a sleeve bearing or bushing grooved on both inside and outside circumferences. These grooves are to distribute the lubricant equally on all the surface of the




REVOLVING GROOVED SLEEVE FOR BEARINGS

bearing. These grooves are all of uniform pitch and the work was done in a common lathe with a turning tool. It might be interesting to some and of benefit to others, who might want to use such a sleeve on close-fitting valve-stem bearings or on loose pulleys. On any high-speed bearing it is exceptionally good and ought to prevent or overcome serious friction troubles and losses.

THOMAS H. DELANEY.

New Bedford, Mass.

## Why Does the Engine Rock?

Recently I visited an engine room in which there is a pair of engines which have been in operation for nearly 30 years. Both engines are now run condensing, and are connected to the same shaft, with cranks set on quarters or 90 deg. apart. A peculiarity of the outfit is the difference in the sizes of engines. One cylinder is 16 in. in diameter, and has a 36-in. stroke, while the other is 20 in. in diameter and has a 42-in. stroke.

Both are supplied from the same steam main and the pressure carried is 110 lb., the speed being 104 r.p.m., one governor controlling both sides by a cross-shaft. While the smaller engine is steady and shows no sign of rocking (a nickel standing on edge indefinitely on the steam-chest cover), the larger one has an end motion of at least ⅛ in. with each stroke. In the small cylinder the feet are part of the cylinder casting, on the larger one the feet are secured to the cylinder by bolts. These bolts have been repeatedly broken as a result of the rocking. The foundation is a brick and mortar affair with granite blocks under the cylinders, governor stand and pillow blocks, and shows that it is more or less saturated with oil. The average indicated load on the small engine is 85 hp., and for the 20-in. side, 180 hp.

Here we have one side of a unit with a stroke of 36 in. and the other with a stroke of 42 in., which makes a piston speed of 624 ft. for one and 728 ft. for the other when running at 104 r.p.m.

Both engines show evidences of at some time having received more water than was good for them, the crank disk on the small one being considerably out of true, due to a sprung shaft end, but this is the side that does not rock.

The master mechanic informed me that he had run a line through the cylinder of the larger engine, and that the crankpin center showed not more than a pencil line out from the head-end center to the crank center. Can readers tell why the other engine rocks?

H. R. Low.

Moosup, Conn.

## Flywheel Bolts Stretch, Due to Centrifugal Force

The main driving belt on a 450-hp. cross-compound Corliss engine pulled apart when running under full load. The engineer who was about 100 ft. away, ran to the engine and shut the throttle valve, thus bringing the engine to a stop.

A splice was made in the belt, which was two-ply. About 90 per cent. of the break was through solid stock and about 10 per cent. through one portion of a lap. The engine was then started. After running at speed for a few moments the flywheel rim was discovered to be running out of true. After shutting down, examination showed that every bolt holding together the halves of the rim was sufficiently loose to allow the nuts to be turned by hand. These nuts were tightened, the hub bolts tested and found to be tight, and the engine run to speed. The flywheel rim then ran as true apparently as before the accident.

Nothing was discovered before or after the accident to indicate that the governor stop did not act to check the speed of the engine after the belt broke. The engineer concluded that the speed of the flywheel had begun to decrease before he shut off steam.

From this it appears that either the flywheel-rim bolts were loose before the belt broke, or that the flywheel-rim speed after the belt broke was sufficient to stretch the bolts, due to the centrifugal force of the rim.

With a 20-ft. diameter, cast-iron flywheel, it would be interesting to have the flywheel designer and the governor expert hand us a few figures, showing how long before the flywheel reaches the bursting speed, does the governor check the speed of the wheel, when full load is instantly thrown off.

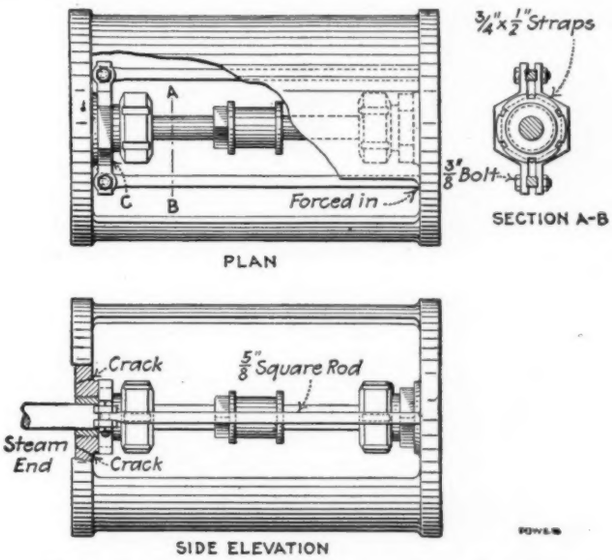
Forrest Allen.

Cleveland, Ohio.

## Emergency Repair to Pump

Water-hammer in an air-bound suction pipe caused the metal around the stuffing-box of a 7x6¾x8-in. duplex service pump to break, as shown in the illustration. The pump was hurriedly repaired as follows:

Two lengths of ¾x½-in. flat-iron were bent into straps to go around the stuffing-box, back of the screw gland. The strap is shown at *C*. Two lengths of ⅝-in. square rod flattened at one end and drilled so as to receive the bolts that passed through the straps were then secured. These rods were a trifle longer than the distance between the straps and the water end of the pump, and were




How Cracked Head of Pump Was Repaired

hinged, being free to move in or out from the pump casing. After treating the break with red lead and when the two ⅝-in. rods were swung in and driven against the water end of the pump, the break was closed so tightly that no leakage whatever occurred. The pump ran in this way for a long time until a new cylinder was obtained.

John Mc A. Howden.

Melbourne, Australia.

## Detector for Locating Knocks and Leaks

A convenient means of detecting the flow of steam through defective steam traps is by the use of an old telephone receiver. The wires are removed and a ¼-in. brass or steel rod about 6 in. long is fastened to the end of the U-shaped magnet.

To detect the flow of steam through a trap, place the rod against the outlet pipe and the receiver to the ear. By this means I recently found six traps discharging steam continuously. The flow of the steam could not

be heard without the telephone receiver, owing to the noise of the surrounding machinery.

This device also locates knocks in an engine.

Cleveland, Ohio. J. E. WASHBURN.

## Clearing Plugged Blowoff Pipes

Where a number of boilers are each connected to a common blowoff main or trunk pipe by short leads from the mud drum or shell, and one of the leads becomes plugged, the obstruction may be removed as follows:

Reduce the pressure in the boiler having the affected lead to about 15 or 20 lb. below that carried by the other boilers. Now close the valve in the trunk line at the outlet end, and open the blowoff valve in the plugged lead. Next open the blowoff valve of one of the boilers carrying the higher pressure. The difference of pressure on each side of the obstruction will tend to break it up and clear the line. After being broken it will usually pass out when the blowoff valve is again opened.

Fall River, Mass. LUKE MARIER.

## Automatic Pump Control

While engaged in installing machinery in a hydro-electric plant the writer's attention was drawn to a novel device in connection with the steam-heating system of the plant. The power house was built to permit the electrical machinery being housed well above the high flood-water

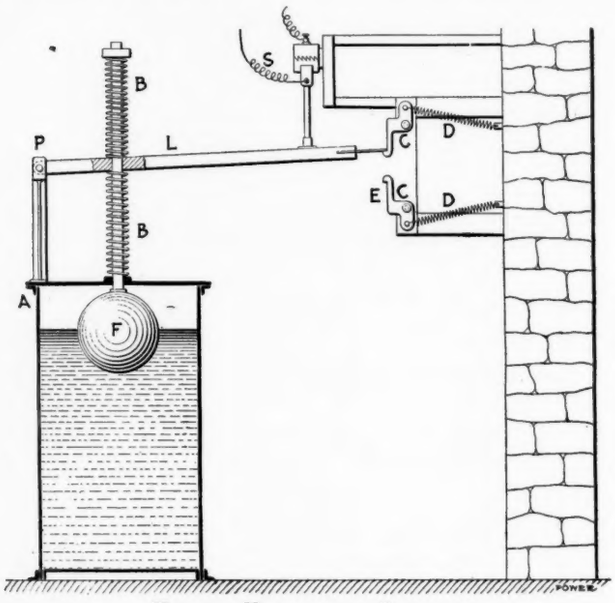



FIG. 1. FLOAT AND CONTACTS

mark, which necessitated the vertical-shaft type of turbines and a height between the basement and main floor of about 30 ft.

The heating boiler was located upon the upper floor, and all drainage of condensed steam from the heating system was returned to the boiler by a motor-driven plunger pump. The drainage was conveyed to a tank from which led the pump suction, and the capacity of the pump was such that the returns could be handled in about one-third the time it took to accumulate a tank full of water. This made an automatic stopping and starting device for the pump desirable.

The chief operator evolved the following scheme, which has now been working satisfactorily for several years: Re-

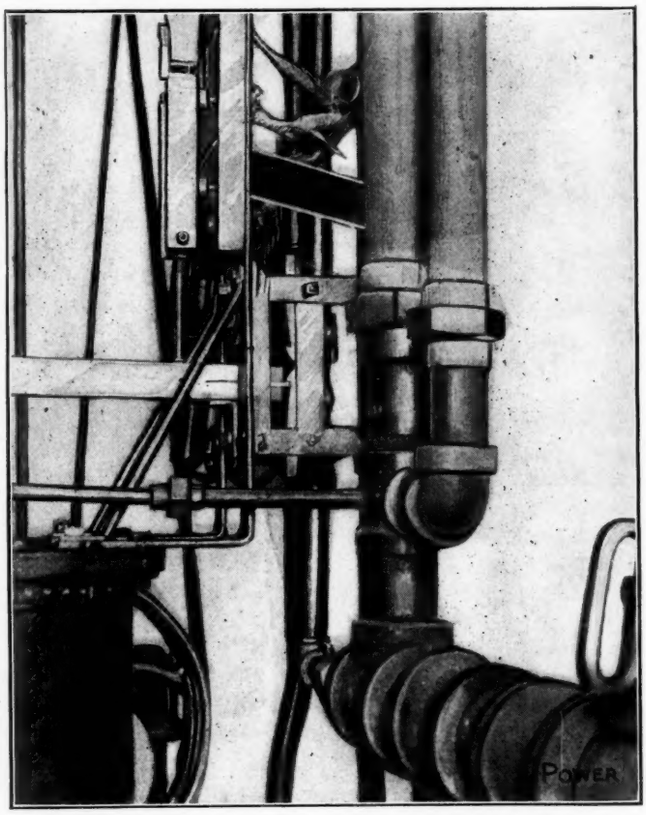



FIG. 2. GENERAL VIEW OF DEVICE

ferring to Fig. 1, *A* is the receiving tank, containing a float *F*, which as the water rises and falls actuates a lever *L*, swinging about the fulcrum *P*. This lever carries one-half of a switch *S* which controls the motor. Two latches *E* swing about the fulcrums *C*. These hold the switch in "on" or "off" position, until the buoyancy of the float when the tank is filling, or its weight when emptying, sufficiently compresses the springs *BB* to overcome the slight friction of the latches on the lever; the switch is thus thrown in or out decisively, and the circuit is made or broken. Two light adjustable springs *DD* suffice to hold the latches lightly in place and help to render the device sensitive. The device was made by Ira Johnson, of Sioux Falls, South Dakota.

Keokuk, Iowa. H. B. MCDERMID.

## Leaky Tubes in Vertical Submerged Tubular Boiler

I have had considerable trouble with leaky tubes in vertical submerged tubular boilers used on steam shovels. After many times retubing and rolling the tubes will not remain tight more than two weeks. The tube sheet has always been thoroughly freed of all foreign matter before retubing. We tried $\frac{1}{32}$-in. copper ferrules in the firebox end of the tubes with little improvement. Cleaning boilers once a month, the average scale deposit on the tube sheet in 2400 hr. operation amounts to ¼ in. thickness. I should like to have readers of POWER suggest the probable cause and advise a remedy.

Covington, Ky. F. J. KRAMER.

# QUESTIONS BEFORE THE HOUSE

## Aftercoolers and Separators

The note by E. R. Pearce on "Air-Receiver Explosions," in the Apr. 29 issue, in which he suggests that the air should pass through oil separators, represents good practice, as far as it goes. I would advocate the use of an aftercooler for the air to pass through first, and then a separator. Both of these devices may be said to cost nothing to operate, unless the small quantity of water passed through the aftercooler is to be charged. The installation cost may be regarded as a paying investment in practically every case. The aftercooler will somewhat reduce the volume of air to be conveyed through the piping, and it will condense the surplus moisture in the air, so that it can be abstracted by the separator, as well as the oil. It will also keep the temperature of the air so low that spontaneous ignition in the receiver and piping will be practically impossible. Both aftercooler and separator are requisite for either of them to completely accomplish its work. The aftercooler will condense the moisture, but will not abstract much of it, and the separator will not abstract the moisture until it has been released by the cooling of the air. The functions of aftercooling and separating might be combined in a single device, but it does not seem to have been done.

It may be worth while to note that the too familiar air-receiver ignitions and explosions are impossible when the air is compressed by the Taylor hydraulic compressor, the Humphrey pump, or a centrifugal or turbo-compressor, because none of these put any oil into the air. For ordinary working pressures, if two-stage compression is employed, with an aftercooler and separator, these precautions may be considered to guarantee immunity. With a rapidly working single-stage compressor delivering the air at the same pressure, without aftercooler or separator, and with an engineer dispensing oil liberally, the guarantee would be reversed, and it would only be a question of time as to when something would happen.

FRANK RICHARDS.

New York City.

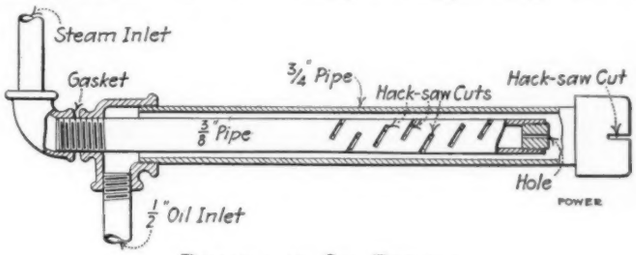
## Home-Made Oil Burner

There are many patented oil burners and hundreds more that are not patented and every engineer in this part of the country has ideas of his own as to what constitutes a good burner. Following are directions for making a burner that gives very good results.

Get a ¾x⅜x½-in. tee, 12 in. of ⅜-in. pipe, 14 in. of ¾-in. pipe, one ¾-in. cap and one ⅜-in. elbow. Thread the ⅜-in. pipe on one end and plug the other end. With a hacksaw cut four, six or eight cuts diagonally across the pipe, the number of cuts being governed by the amount of work required of the burner. Now drill a small hole in the end of the plug like a miniature nozzle, dress the pipe over the saw cuts with a file and if any rough cuts have been made, peen them even to make a flat jet of steam from each cut strike the oil. Screw this pipe into the tee through the ¾-in. end and let it come through far enough to screw on the ⅜-in. elbow. Now screw the ¾-in. pipe into the tee outside the ⅜-in. pipe and get the ⅜-in. pipe in the center of the larger one.

Cut an opening in the ¾-in. cap with a saw, the size of the opening to be governed by the amount of fire needed. For a small boiler, a coarse saw cut is sufficient with four cuts in the mixer, for a large boiler make more cuts in the mixer and a larger opening in the cap. Use a needle valve on the oil-admission pipe and let the oil to the burner under 40 or 50 lb. pressure and at about 140 deg. F.

Insert the burner through the fire-doors about the center of the firebox and do not let the blaze strike the boiler. Keep a bright incandescent fire by giving the proper amount of steam and oil and keep the stack damper as nearly closed as possible. Keep the ashpit dampers 4 to




DETAILS OF OIL BURNER

6 in. open, just so quite a draft of air can be felt going into the pit.

An evaporation of 13.8 lb. of water to 1 lb. of oil has been attained with installations equipped with this burner.

J. E. PELTON.

Portland, Ore.

## Algae in Water

Noting the inquiry in POWER for May 6, 1913, as to killing algae in water, the usually accepted method is to treat the water with copper sulphate, only about one part of which is required to sterilize 4,000,000 to 5,000,000 parts of water. Water so treated seems to be innocuous as far as drinking is concerned, or for laundry and similar industrial purposes. It will not do for irrigation, as it kills vegetation, just as it does the algae.

For boiler purposes, I do not know how it would be, but I saw some water carrying several hundredths of a per cent. of copper sulphate once used in several water-tube boilers with great profit to the tube makers. The iron of the boiler tubes cemented out the copper and then let go. Pending reports from a reader who has used copper-sulphate treated water in boilers, it might be well to treat the water in turn to get rid of copper sulphate; lime and soda-ash treatment should be effective.

DONALD M. LIDDELL.

Elizabeth, N. J.

## Pressure in Standpipe

On page 723 of the May 20 issue under "Inquiries of General Interest," is the problem of the vacuum gages on the closed standpipe.

The diagram given shows the absolute pressures all right, but vacuum gages would read difference of pressure below atmosphere and the text distinctly says, "this would be the reading ——," etc. This I fear is misleading and gives the wrong idea, for I had to think it over some to get it straight.

S. B. REDFIELD.

Phillipsburg, N. J.

[It is customary in scientific computations, to avoid confusion, to use absolute pressures, which was our reason for so doing in explaining the gage problem. Gages are made which read that way, but commercial vacuum gages generally read as our critic indicates, i.e., in inches of mercury or pounds per square inch below atmospheric pressure. The following table gives the readings in all the different ways:

| Gage | Pressure Absolute Ft. Water | Lb. | In. Mer. | Vacuum below Atmosphere Ft. Water | Lb. | In. Mer. |
|---|---|---|---|---|---|---|
| First Condition | | | | | | |
| A..... | 19 | 8.23 | 16.78 | 15 | 6.5 | 13.25 |
| B..... | 24 | 10.39 | 21.19 | 10 | 4.33 | 8.83 |
| C..... | 29 | 12.56 | 25.61 | 5 | 2.17 | 4.42 |
| Second Condition | | | | | | |
| A..... | 24 | 10.39 | 21.19 | 10 | 4.33 | 8.83 |
| B..... | 24 | 10.39 | 21.19 | 10 | 4.33 | 8.83 |
| C..... | 29 | 12.56 | 25.61 | 5 | 2.17 | 4.42 |

—EDITOR.]

## Water-Tube Versus Fire-Tube Boilers

In the May 6 issue, F. W. Dean deals some severe blows to the water-tube boiler as a steam generator for textile mill plants. He also mentions two disadvantages in using them, namely: They are more expensive to operate and they are more dangerous.

In regard to the cost of operation, I find that out of 15 tests each on water-tube and return-tubular boilers, the best record for evaporation on any of the return-tubular boilers was exceeded in several instances by the water-tube type. These tests were made under good conditions, but let us consider the average conditions under which textile mill plants may be run, for the boilers are not always kept up in the best condition and especially is this so if the feed water is of poor quality.

In any type of fire-tube boiler using water containing scale in solution, when the scale has accumulated on the surfaces of the tubes it is difficult to get at it except on the tubes that are nearest the point where a man can get in to work. In the large vertical boiler there are no manholes so that everything must be done from the handholes, and any engineer knows how difficult this is when the scale has gathered in the central part some distance above the lower tube sheet.

In a water-tube boiler of the horizontal-drum type with inclined tubes, every part of the water surface can be seen, so that it can be carefully examined and is accessible for cleaning. Thus when the water-tube boiler is finished it is known with certainty that it is in good shape. The extra labor of taking off and putting on handhole covers is well repaid by the higher rate of evaporation due to the absence of scale. In the fire-tube type it is largely guesswork as to the degree of cleanliness attained.

As to the accumulation of soot, the fire-tube can be allowed to run so long that it will be plugged solid and the gases cannot get through. Such a condition could not prevail in a water-tube boiler, for after the soot had accumulated to a certain depth on top of the tube it would begin to roll off. The under side of the tube will remain fairly free from soot indefinitely.

The amount of heating surface taken up by a set of vertical baffles is so little that it can safely be neglected when it is considered that the water-tube boiler has superior steaming qualities. The side openings in some boilers can be kept as tight as the back arch connection on return-tubular boilers, and one prominent make of boiler does not have these openings at all. In the vertical fire-tube boiler with the furnace all enclosed by water surface the combustion is not as good as in the brick-lined furnaces which retain the heat and do not chill the gases.

In regard to the number of accidents, Mr. Dean would probably find extenuating circumstances in most of the explosions. There are many types of water-tube boilers on the market and it is possible that some of them are not all that they should be, but there are some that have had years of hard service in all kinds of plants and these should be used as guides when a comparison is made with the return-tubular boiler.

The statement is also made that in the water-tube boiler the tubes are expanded into the drums. This is not true in all cases. In the Stirling boiler the tubes are expanded into the drums but the sheet is thick so that it can easily stand the strain. The expansion is compensated for by the tubes. In the Babcock & Wilcox boiler there are nipples expanded into a throat sheet which has unusual strength. The long service of some of these boilers has not disclosed a weakness in that feature of their construction.

In the water-tube boiler there is no uncertainty about the condition of the blowoff pipe, for it is outside of the setting instead of in the direct heat of the gases. The shells of water-tube boilers are up high, away from the hottest gases, so that they are not under excessive strain, and by reason of their convex heads and small diameter they need no staying. The plates are thinner and in the best makes they are made up with butt joints.

The tubes have the hardest service, but when they are worn out and a new set becomes necessary, the boiler is nearly as good as ever, for it is capable of withstanding the original pressure. In the return-tubular boiler after the shell has deteriorated the pressure must be gradually reduced until the boiler is discarded.

Mr. Dean favors the use of large units of 400 or 500 hp.; but there are few if any shell boilers that will develop that power at their normal rating while such sizes are common among water-tube boilers. To raise the horsepower of the shell boiler it is necessary to increase the diameter of the shell, while with the water-tube type more tubes and more drums can be added, and this does not affect the factor of safety at all.

It is my opinion that any textile mill can get as good, and in most cases better, service from the water-tube boiler than from any other type.

East Dedham, Mass. G. H. KIMBALL.

# INQUIRIES OF GENERAL INTEREST

**Heated Eccentric**—If an eccentric and strap should run hot what should be done to fix them so as to run again?

H. L. R.

The eccentric halves should be parted and shims inserted.

---

**Amount of Compression**—Should a tandem-compound condensing engine be given as much compression as a cross-compound condensing engine?

E. P.

For smooth running a tandem-compound condensing engine should be given compression the same as a simple non-condensing engine; but in cross-compound condensing engines only enough compression is given to distribute the steam and operate the valve properly.

---

**Pumping Height**—To what height can a pump force water if the steam cylinder is 8 in. in diameter, the water cylinder 5 in. in diameter and the steam pressure 80 lb.?

H. L. R.

Neglecting friction the pump would exert

$$\frac{8 \times 8}{5 \times 5} = \frac{64}{25} = 2.56$$

times as much pressure per square inch in the water cylinder as would be exerted on the steam piston. Therefore, if the steam pressure is 80 lb. per sq.in. the pressure developed in the water cylinder might be

$$2.56 \times 80 = 204.80 \text{ lb. per sq.in.}$$

As 1 lb. pressure of water is equivalent to the pressure due to a head of 2.309 ft., then 204.80 lb. per sq.in. in the water cylinder of the pump would raise the water

$$204.80 \times 2.309 = 472.88 \text{ ft.}$$

---

**Hammering in Pump Discharge**—How can water or air hammering in the discharge pipe of a cold-water pump be stopped?

C. G. O.

Usually by connecting an air chamber on the line near the pump. This should have a volume of at least three times that of the water cylinder of the pump. The air chamber may be an ordinary pump air chamber, or may be made of a piece of large pipe set up vertically. The connection of the air chamber to the main discharge pipe should be the same size as the latter, and should have a stop valve. The air chamber should have a pet-cock on top and one near the bottom for testing whether there is any air cushion present. Any time it is found to have disappeared the main stop valve should be closed, the lower pet-cock opened for draining the air chamber and the upper air cock opened to admit air.

---

**Piston-Rod Displacement Allowance**—What allowance or correction is usually made for the volume of the piston rod in the crank side of the cylinder of a steam engine?

E. P.

There is no need to make any allowance for the cylinder space taken up by the piston rod, nor to take account of the piston-rod's reduction of the effective area on the crank side of the piston, for piston rods usually are only one-sixth the diameter of the piston This means that they reduce the piston area only $1/36$, which is less than 3 per cent., and for all ordinary considerations of steam distribution the space taken up by the piston rod may be neglected. On very large engines when the size of rods is considerable, allowance is usually made by causing a higher mean effective pressure on the piston-rod side so as to obtain equal power in both ends of the cylinder. This is accomplished by adjusting the valve gear so as to obtain a later cutoff on the crank end or an earlier one on the head end.

---

**Compound Engine Cylinder Proportions**—What are the right proportions for the cylinders of compound, triple-expansion and quadruple-expansion engines?

H. L. R.

Authorities differ as to the best proportions for the volumes of the high- and low-pressure cylinders of a compound-engine, varying from 1:3 to 1:5. In triple-expansion engines and quadruple-expansion engines the same is true. A common rule for a triple-expansion engine is to design the low-pressure large enough to furnish the entire power required at the mean pressure due to the initial pressure and the expansion ratio given. Then this cylinder is given only pressure enough to perform one-third of the work and the other cylinders are so proportioned as to divide the other two-thirds between them. In quadruple-expansion engines the ratios of cylinders for very best economy vary for different initial pressures and vacuums so that different designers will naturally vary in their opinions with respect to proportions. Quadruple-expansion engines intended to be operated at a pressure of 180 lb. per sq.in. are given cylinder ratios of about 1:2:4:8.

---

**Determining Chimney Size**—What rule may be used to find the size of chimney required for a given horsepower capacity of boilers?

J. P.

If the boiler horsepower is given and the chimney height (H) assumed, the effective area (E), in square feet, may be found by the formula

$$E = \frac{0.3 \text{ Hp.}}{\sqrt{H}}$$

For round chimneys the actual diameter should be the diameter of the effective area plus 4 in. and for square chimneys each side should be the side of a square of an area equal to the effective area (i.e., the square root of the effective area) plus 4 in.

As an example, suppose it is required to find the diameter of a round stack, 81 ft. high, which would be suitable for 100 hp. Substituting the values,

$$E = \frac{(0.3 \times 100)}{\sqrt{81}} = 3.33 \text{ sq.ft.}$$

or

$$3.33 \times 144 = 479.52 \text{ sq.in.}$$

which is the area of a circle of about 24¾ in. in diameter. Therefore, the actual diameter should be

$$24.75 + 4 = 28.75 \text{ in.}$$

---

**Suction-Pipe Flow**—What is the maximum amount of water in U. S. gallons per minute, that can be raised by a vacuum at sea level through a 1¼-in. pipe?

A. P. S.

This will depend on the roughness and length of the pipe and the perfection of the vacuum. With a perfect vacuum a rate of flow would be created equal to one corresponding to a head of 34 ft., but an ordinary good pump with tight connections could not be depended upon to exceed an equivalent of about 25 ft. of head.

The flow of water taking place under various heads and for various lengths of wrought-iron pipe is treated of in an article "Flow of Water in Pipes and Flumes," in "Power," Nov. 10, 1908, pages 775 to 780.

From diagrams in this article, assuming the suction pipe to be 10 ft. long, it may be found that for a total head of 34 ft. the pipe friction would be about

$$\frac{200}{100} \times 10 = 20 \text{ ft. loss of head}$$

Velocity head = 10 ft.

and

Entrance head = 4 ft.

Total = 34 ft. head

and the discharge about 75 gal. per min.

With a vacuum equal to about 25 ft., the pipe friction would be about

$$\frac{60}{100} \times 10 = 16 \text{ ft. loss of head}$$

Velocity head = 6 ft. and

Entrance head = 3 ft.

Total = 25-ft. head

and the discharge would be about 65 gal. per min.

# ENGINEERS' STUDY COURSE

## Making a Flue-Gas Analysis—Part III

### Loading Apparatus

The correct amount of chemical must be put into each pipette or otherwise the apparatus will not work well. Remove the gooseneck from the rear leg of the pipette and add the chemical through the glass funnel until the two legs are slightly more than half full. In order that the liquid may rise equally in both legs the stop cock in the front connection must be open and also the three-way cock *P* in the header (shown in Fig. 1, repeated from last lesson) must be open to the atmosphere. After you have filled one pipette *J*, for instance, tested it and found it to contain the proper quantity of liquid, it is an easy matter to get the other two correct simply by filling them to the same level.

To test whether pipette *J* contains the right quantity of liquid, fill the leveling bottle *I* about two-thirds full

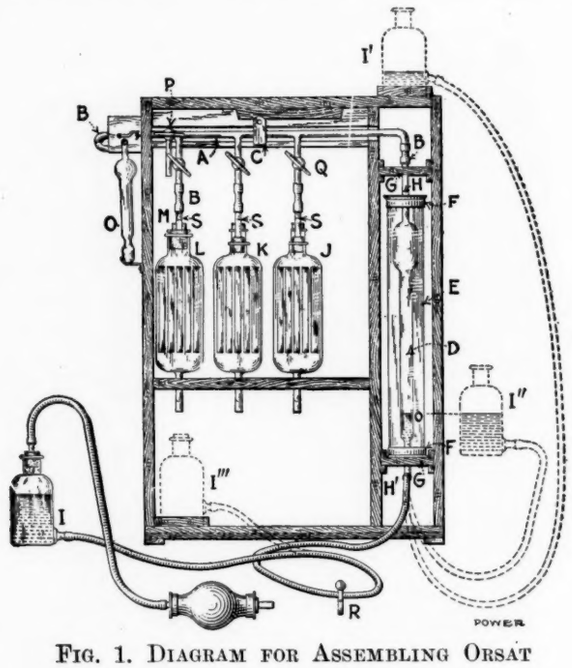



Fig. 1. Diagram for Assembling Orsat

of water, first closing the pinch cock *R*. See that all the glass cocks connecting with the header are closed except cock *Q*, which must remain open. Now, raise the leveling bottle and place it on top of the cabinet as at *I'*. Then, press the buttons of the pinch cock *R* until the water begins to rise in the burette. This places the air trapped above the water in the burette and in the header under a slight pressure and as the stop cock *Q* is open this pressure is communicated to the front leg of the pipette *J*, driving the liquid down in this leg and up in the back leg. By regulating the pressure of your fingers on the pinch cock *R* you can control the flow very nicely. If the pipette contains the correct amount of liquid, by the time the liquid has gone down in the front leg to the point where the body part begins to narrow into the bottom-connecting tube, the liquid in the back leg will have risen to the point where the body part begins to narrow into the neck at the top.

If too much liquid has been put into the pipette, the back leg will be full or overflowing before the front leg has been emptied to the point mentioned in the preceding paragraph, and some of the liquid will have to be removed. If not enough liquid has been put in, air will force its way through the bottom connection and bubble up through the liquid in the back leg. To prevent this, more liquid must be added.

### Emptying Pipettes

After the apparatus has been used for some time, the chemicals become weak and must be renewed. A convenient way of emptying a pipette is to fill a short length of rubber tubing (about 3 ft. long) with water, and while holding your finger over one end, to prevent the water from running out, put the other end into the back leg of the pipette. Then, lower the free end into a sink or basin so that this end is somewhat below the other and release your finger, when the liquid will all siphon out of the pipette.

### Preparing for an Analysis

After all three pipettes have been properly filled and tested the apparatus is almost ready for making analyses. Before it is quite ready, however, the liquid in each pipette must be drawn up into the front leg until this leg is full to the fine black ring, which will be found around the neck at *S*.

To do this in the case of pipette *J*, notice whether the water level in the burette *D* is near the top. If it is not, close all the header-connection cocks except the three-way cock *P*, which must be open. Then, raise the leveling bottle to *I'* and allow the water level to rise in the burette by opening the pinch cock *R*. When the water level in the burette is right, close the three-way cock and open stop-cock *Q*. Lower the leveling bottle to the table and by releasing pinch cock *R* allow the water in the burette to run back into the bottle; while doing do, watch the liquid rise in the front leg of *J*. When this is near the top, proceed very slowly and carefully as the necks *M* (made of what is known as capillary tubing) have a very fine bore, and if you allow the liquid to rise too rapidly when near the top, there is considerable danger that it will shoot up into the header and over into the burette before you can check it. While this will do no harm when practicing with water, it is undesirable when dealing with the chemicals, as it makes the water in the burette more or less capable of absorbing the flue gases, thus causing error, and it reduces the quantity of liquid in the pipette so that trouble may arise in this direction also.

The proceeding for bringing the liquid in pipettes *K* and *L* up to the mark is exactly the same as for pipette

*J*, only, while doing so, it is advisable to remove the goosenecks with the rubber bags attached, from the mouth of the back legs, for unless there happens to be enough air in these bags, a vacuum may be formed over the liquid in the back leg, thereby preventing it from coming fully up to the mark in the front leg as it should. As soon as the liquid has been brought up to the mark, replace the goosenecks and rubber bags to prevent further contact with the outside air. When dealing with the chemicals, the air that it trapped in the back leg of *K* and *L* will lose its oxygen, and, hence, shrink in volume so that a slight vacuum will be formed. When this noticeably interferes with the operation of the apparatus, remove the gooseneck for an instant to let in a little more air. Be sure to do this, however, when the liquid is up to the mark in the front leg or when the gas bag is perfectly flat or empty, as otherwise, instead of letting more air into the system, you will really let some out and cause a worse vacuum than ever.

A better way to avoid trouble from the formation of a vacuum is to force a little excess air into the bag by blowing into it with your mouth, then, pinching the neck to hold the air in until the connection is made. It is well to take precaution, however, when doing this, and be sure that there is none of the chemical on the end you put to your lips, as otherwise you may burn yourself.

With the liquid in all pipettes properly adjusted, an analysis can now be made. That is, we can go through the motions of making an analysis. Later, when more practice has been gained, we will load with the proper chemicals and after making suitable arrangements for obtaining a sample of the flue gases, we will be prepared for actual work.

### Size of Sample

For the present, assume that the filter *O* is connected with the supply of gas. Our sample will consist of 100 c.c. of flue gas at atmospheric pressure and at the temperature of the ordinary room air.

At its lower part, where all our readings will be taken, the burette is graduated in cubic centimeters with a subdivision for each 0.2 of a cubic centimeter. Thus, the figures of the scale read direct in per cents. and decimal fractions of a per cent.

A cubic centimeter is another French or metric unit employed because of its great convenience, like the gram, decigram and milligram in our proximate coal analysis. The metric units of length, corresponding with inches, feet and yards, are the centimeter, decimeter and meter. Consequently, the units of volume are the cubic centimeter, cubic decimeter and cubic meter. Do not fall into the mistake, however, of assuming that 100 c.c. equals one cubic meter, for they do not—no more than 12 cu.in. equal one cubic foot. At the bottom of the scale on the Orsat burette you will find the letters c.c., which is the standard abbreviation for cubic centimeter.

### Effect of Temperature and Pressure

You may have noticed that I specified that our gas sample was to be at a certain pressure and temperature. This is because the volume of a gas is greatly influenced by changes in pressure and temperature. Hence, we must be careful to have conditions uniform throughout an analysis, or error will result. It is advisable for best results to locate the apparatus where no drafts will blow on it and where the temperature of the air does not change rapidly.

To illustrate how important an influence temperature and pressure have, two simple experiments can be made with your Orsat.

To show the effects of change in temperature, locate the apparatus in a warm spot and allow it to remain there for about an hour, until the glass work and the water come up to the temperature of the air. Then, with all cocks closed except *P*, which must be open, slowly raise or lower the leveling bottle, using the side of the cabinet as a guide, until the water level in the burette *D* is exactly on the zero mark, while at the same time the water level in the bottle is at the same height as the water level in the burette, as shown by the position of the bottle at *I″*. Then, using care not to change the level of the bottle, close cock *P*. To make sure that no mistake has been made while closing the cock *P*, check the water levels once more by noting whether both are at the level of the zero mark. If not, and if they cannot be brought right by a slight raising or lowering of the bottle, open the cock *P* and start all over again.

Having thus succeeded in getting the correct quantity of warm air into the burette, place the leveling bottle in its cleat within the cabinet at *I‴* and shift the apparatus to some spot where the temperature is 10 or 15 deg. cooler. After about an hour's time, test the water level again (without opening cock *P*) by slowly raising and lowering the leveling bottle at the side of the cabinet until the level in the bottle is the same as the level in the burette. This new level will be considerably above the zero mark, showing that the reduction in temperature caused the volume of the air in the burette to shrink. A reduction in temperature of 10 deg. means a reduction in volume of about 1.8 per cent.

To show the effect of change in pressure, open cock *P* and by raising or lowering the leveling bottle, draw in enough air to bring the water level to about the 10 per cent. mark. Close cock *P* and make an accurate reading by raising or lowering the bottle until the water level is the same in the bottle and in the burette. Now, if you raise the bottle, say, to position *I′*, the water level in the burette will rise almost to the 14 per cent. mark. This shows that the tendency of the water in the bottle to flow into the burette and seek its own level has put an increase of pressure on the air trapped in the burette and, hence, has reduced its volume by compression.

### Manipulation of Three-Way Cock

Thus far, I have said nothing about the manipulation of the three-way cock *P*. Its correct manipulation is very important when making an actual analysis, and as a poor understanding of how it should be handled would undoubtedly lead to confusion and inaccuracy in results, it is worth devoting a paragraph at this point to this important part of the machine.

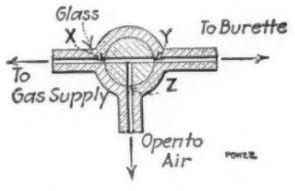



Fig. 4. Diagram of Three-Way Cock

Fig. 4 is a diagram of the three-way cock connection. The straight-run passage *XY* is parallel with the handle

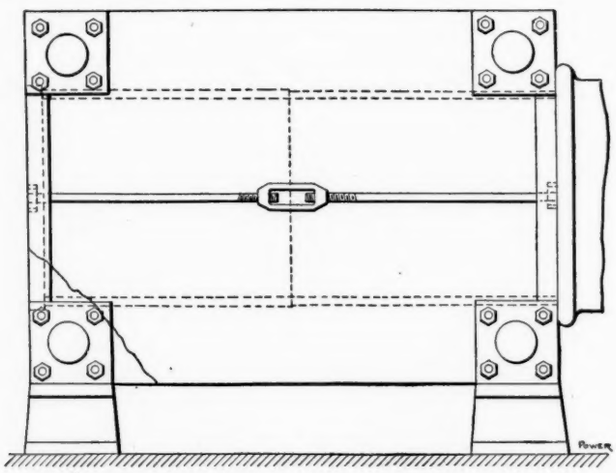
of the cock and the branch connection *Z* is on the same side as a dark dot found on the handle. In the position shown in Fig. 4 (in which position the handle would be horizontal and the dot would be facing down) the gas supply, the outside air and the burette, would all be connected.

In the reverse position (with handle horizontal and dot facing up) only the gas supply and the burette would be connected. With the handle in a vertical position and the dot facing to the left the gas supply and the outside air would be connected. With the handle vertical and the dot to the right, the burette and the air would be connected. With the handle in any 45-deg. position no connections would be open. In the next lesson the instructions for setting up will be continued and the tests for oxygen, carbon monoxide and carbon dioxide explained.

## Repairing a Broken Cylinder

By W. H. Wakeman

The cylinder of a Corliss engine was broken in some unknown way, near the head-end exhaust port, as shown by the irregular diagonal line. The internal diameter of this cylinder was 14 in., but the engine carried only a light load, hence it was practicable to repair the damage by inserting a cast-iron bushing 1 in. thick, thus reducing the diameter to 12 in. The stroke is 36 in.



How the Cracked Cylinder Was Repaired

In order to secure a true circle in the cylinder, it was rebored. The first half of the length was made larger than the remainder, as shown in the illustration, therefore, when the bushing was inserted it went in easily to this extent, but it was necessary to use much force to put it into the required position, as it was 0.004 in. larger than the cylinder. Near the outer end a raised shoulder $\frac{1}{8}$ in. high and $1\frac{3}{4}$ in. long, was provided to hold the broken part in place. This was made a sliding fit in the cylinder, to avoid expanding the cracked portion. Screws were put through the cylinder into this bushing to hold it in place, but care was taken to avoid boring holes completely through the bushing.

A turn buckle was used on each side as illustrated, thus providing additional security against any possible movement of the bushing. While this was an expensive job, it cost less than a new cylinder, and the necessary shutdown of the works was comparatively short.

## OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

"Where am I going the Fourth? To work! Just like I do on all other holidays and Sundays. Get a day off? Yes, when they put eight days in a week. Say, kid, they tell me I ought to be glad to be living, and have a steady job. It's some steady, all right.

"I had a dandy vacation two months ago—when I was laid up with the rheumatism—for three weeks. What'cher got on your mind, bub? You thought a power-plant engineer was a human being; needed a rest like other folks? Not on your fragile existence! He just keeps going, and going, and going—till he reaches the scrap heap. Gee! Ain't you never known an engineer before?"

A refrigerating plant with a daily capacity of seven tons has been installed in the White House. It ought to help the President to turn a cold shoulder to the over-persistent office seeker. It's also a shop kink for the Secretary of State that might help him in keeping his grape-juice policy up (or down, if you drink) to the mark.

Nearly 800 degrees at Yale.—Headline.

Must have been a hot time at our college during commencement, son. In the parade they sang "Onward Christian Soldiers." Even when the mercury has shinned up to 100 deg. it requires considerable fortitude for us to chant "A Hot Time in the Old Town."

Going up! A young elevator "engineer" has had $200,000 wished on him by a grateful New York manufacturer of engineering materials. The elevator man once saved the life of this now deceased gentleman. Mrs. Engineer says that, if she has her way (and they generally do), they will settle down, put this neat little wad into real estate, "and raise a big family." We quote the lady's own words, and hope that her very laudable ambition will come true. P. S.—The proofreader says this is a dream. All right, it's a good one.

Speaking of big families, did you know that a fly lays 120 eggs four times each season between May 1 and Sept. 30? And the flies therefrom number.

9,134,843,744,256,000,000,000,000

Mebbe a few hid themselves on the count, but it's near enough to worry the bald-heads. And we're trying to swat this pest into a place some high forehead calls oblivion.

Having fixed the number, now it's up to some bally ass to ascertain their exact weight. In fawncy, we can hear some member of the Weight Committee at the coming Springfield convention declare. S-O-M-E W-E-I-G-H-T!

"RECHARGING A DRY BATTERY"

Unless your eye has already focused the clever picture below, you will probably conclude from the title that this much discussed subject has oozed over from the electrical department.

This is such an efficient way of recharging this particular type of dry battery that when we saw it in Brother Clarke's "Gas Review," we got his permission to reproduce it.

# Successful Small Insolated Plant

*SYNOPSIS—This plant, although small, displaced central-station service, making a saving of $2000 per year. The equipment is of standard type. The chief engineer has supervision of the entire mechanical equipment of the factory.*

Motive power for the factory of Larned, Carter & Co., Detroit, Mich., was purchased from the central station for several years before John Gunn, the present chief engineer, took charge. By dint of much convincing reasoning and the use of cost figures, of which he was absolutely certain, he finally persuaded the owners to install electrical generating equipment. So skeptical were they, however, of the success of the venture, that the builder of the engine installed was forced to agree to take his pay out of the saving he predicted would result.

The power plant has been in operation for about two years, and the results obtained have been so satisfactory that the engine man was paid in full in less than a year.

The factory consists of two buildings, one of which is three stories high and 75x130 ft. in area, and the other, five stories high and 50x130 ft. Thirty-five motors, the majority of which are of 3- and 5-hp. capacity, and two elevator motors, one of 10 and one of 15 hp., furnish the power load, some fifteen hundred 16-cp. incandescent lamps furnish the lighting load. The current requirement is quite uniform, never falling below 90 or exceeding 100 kw. This and the fact that the plant is constantly maintained in the best possible condition and

FIG. 1. BOILERS AND STOKERS

operated so as to yield the highest all-around economy accounts for the unusually good showing made.

Complete cost figures are not available, but the general summary is true that allowing 15 per cent. per year for depreciation, maintenance, insurance, etc., on the $12,000 invested for the extra equipment installed, the annual saving is about $2000.

## BOILERS AND STOKERS

Fig. 1 shows the boilers and stokers. The nearer one is a return-tubular, 60 in. by 14 ft. in size, having 64 tubes, 3½ in. in diameter, and rated at 90 hp. This boiler has been in since 1902, and before the power equipment was installed it was used for heating work only. The steam pressure then carried was 90 lb. gage. The

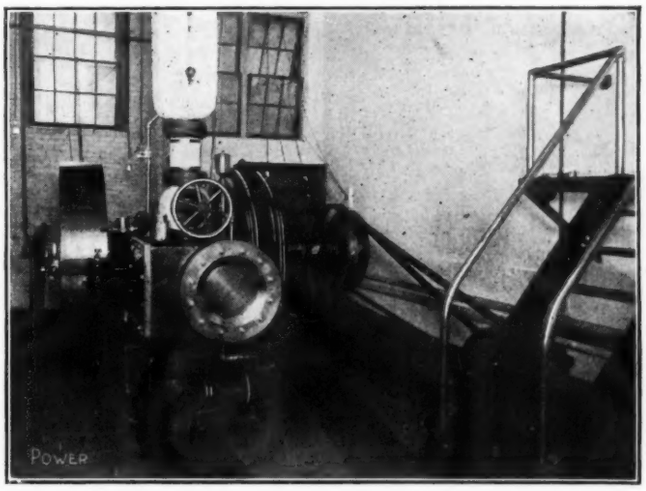



FIG. 2. ENGINE AND DYNAMO

pressure at present carried is 85 lb., gage, although 125 lb. is allowed by the insurance company. The farther boiler is a 125-hp. return-tubular, 72 in. by 14 ft. in size, having 86 tubes, 3½ in. in diameter. It has been in service the two years the generating equipment has been installed.

Each boiler is fitted with an under-feed stoker. As the generator is operated only from 7:15 a.m. to 4:30 p.m., and until 11:30 a.m. on Saturdays, but one shift is needed in the plant. The fireman gets down about 6:30 a.m. and starts the stoker-fan engine on whatever steam pressure the boilers have retained over night, and in a short while the working pressure is built up so that the generator can be started and take the load as soon as the 7:15 whistle blows. Shortly before stopping time, the fires are cleaned and put into good condition for banking and the stoker plunger is stopped. Thus, by the time the engine has been shut down the boilers have practically ceased making steam and are ready to be laid up for the night.

Forced draft for the stokers is furnished by a 32x10-in. steel-plate fan driven by an 18-hp. vertical engine, the speed of which is automatically regulated to suit the steam requirements by means of an automatic pressure valve. Each boiler has its own stack; the one for the small boiler is of brick, 75 ft. high and 24 in. square, inside, and the one for the large boiler is of iron, 90 ft. high and 24 in. in diameter inside. Island Creek nut, pea and slack coal, mixed, costing $2.50 delivered, is used as fuel.

The feed water is heated in an 80-hp. open heater arranged with a bypass. Returns enter the heater direct from the exhaust-steam heating system during the winter season. An oil separator in the exhaust line removes a large percentage of the cylinder oil from the steam, so

PRINCIPAL EQUIPMENT OF LARNED, CARTER & CO.'S PLANT

| No. | Equipment | Type | Purpose | Kw. | Volts | Cycles | Phase | Size | Hp. | Speed | Press. Lb. | Manufacturers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Boiler | Return tubular | Steam gen. | | | | | 60″x14′ | 90 | | 85 | Gem City Boiler Co. |
| 1 | | | | | | | | 72″x14′ | 125 | | 85 | Wickes Boiler Co. |
| 2 | Stokers | Jones | Boiler furnace | | | | | | | | | Under Feed Stoker Co. of America |
| 1 | Heater | Open | Feed water | | | | | | 80 | | | Harrison Safety Boiler Works |
| 1 | Separator | Oil | Exhaust | | | | | | | | | Austin Separator Co. |
| 1 | | Steam | Line steam | | | | | | | | | |
| 1 | Pump | Duplex | Boiler feed | | | | | 5½x3½x5″ | | | 85 | Deane Steam Pump Co. |
| 1 | Engine | Simple | Main unit | | | | | 17x18″ | | 225 | 85 | Skinner Engine Co. |
| 1 | Generator | A. C. | Main unit | 150 | | 60 | 3 | | | 225 | | Fort Wayne Electric Works |
| 1 | | D. C. | Exciter | 8 | 125 | | | | | | | |
| 1 | | | Auxiliary | 3½ | | | | | | | | |
| 2 | Blowers | Diamond | Tube | | | | | | | | | Diamond Power Specialty Co. |

that but a very small quantity indeed finds its way to the boilers. The boiler-feed pump is a 5¼x3½x5 in. duplex, and is regulated by hand.

### Generating Equipment

The generating equipment is shown in Fig. 2. A 17x18-in. simple engine, which runs at 225 r.p.m., is direct connected to a 150-kw. alternating-current dynamo, which generates 60-cycle, three-phase current at 220 volts. The 8-kw. exciter is belt driven from the larger pulley attached to the outboard end of the shaft. A second direct-current dynamo is belt driven from the smaller pulley. This machine has a capacity of 3½ kw., and is employed to furnish current for a number of ⅛-hp. motors for portable cloth-cutting machines.

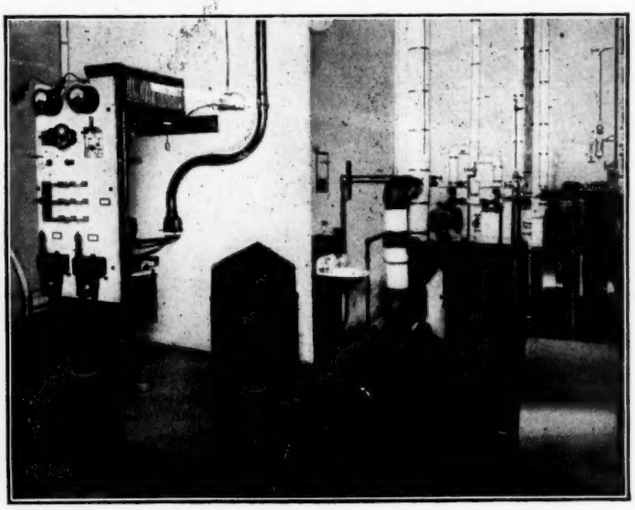


Fig. 3. Switchboard and Steam Auxiliaries

Steam is supplied to the main engine and the auxiliaries through a 6-in. header. The engine is equipped with a steam separator of ample capacity, as shown. The exhaust pipe drops straight down and makes connection below the floor level with the heating main, feed-water heater and the atmospheric exhaust stack.

The switchboard, the heater and the stoker fan and engine are shown in Fig. 3. The switchboard consists of one panel 2 ft. 6 in. wide by 5 ft. high. The generator and exciter rheostats are mounted at the top and rear of the board and adjusted by handwheels. A single voltmeter, ammeter and ground light is used, being connected with either phase, by a three-point switch. One feeder cable extends to each of the factory buildings and is controlled by a combination oil-break circuit-breaker and disconnecting switch. An emergency connection can be established with the central-station distribution system by means of a three-pole double-throw main switch mounted in the middle of the board.

All piping, including the boiler feed, exhaust steam, stoker and stoker engine, is controlled in the engine room.

The engine is equipped with a self-contained oiling system, consisting of a receiving well, strainer and filter, pump, and the necessary piping to the various bearings and other parts. Every two weeks the old oil is drawn off and 2 gal. of fresh oil supplied. The old oil is used in the factory for lubricating pulleys, shafting, etc. The cylinder-oil consumption averages 9 gal. per month.

During the summer the boilers are cleaned once every four or five weeks, and in the winter, every eight weeks.

❖

## Neco Feed-Water Regulator

The main feature of this regulator is that it is designed to decrease the water level in a steam boiler when the load increases and to increase the water level when the load decreases. It is manufactured by the Northern Equipment Co., 408 West Indiana St., Chicago, Ill.

The Neco regulator depends for its operation upon the admission of steam or water into the expansion tube, the steam flow being dependent upon the water level, *i.e.*, whether it is above or below the connection to the upper end of the tube.

With the water below the center gage, steam flows to the expansion tube, thereby expanding it with the heat and forcing it against the short arm *OD* of the bell-crank *DOE*. The arm *OE* in turn rises and, lifting the weighted toggle arm *F*, opens the feed valve.

The flow of water through the opened feed valve raises the level and the steam supply is cut off. The steam already in the tube condenses and the tube deprived of the constant heat required to maintain it expanded, contracts, thereby drawing back the arm *OD* and lowering the arm *OE*, which allows the weighted toggle arm *F* to force shut the feed valve by gravity.

To avoid a recurrent complete opening and a complete closing of the valve a toggle motion is used. The arc of the point *H* is such that when the arm *F* is raised, the motion is at first slight and the valve is opened but slightly. Later, the speed of the motion increases as the point *H* moves upward in its arc.

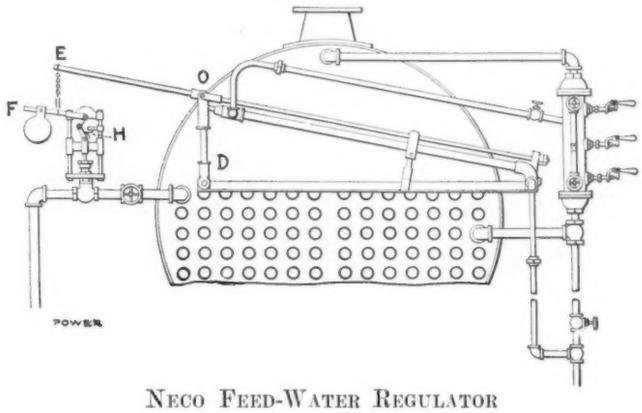
In reverse fashion, as the contracting tube allows the arm *F* to force the valve shut, the closing is at first rapid and then so slow that before the contraction is complete and the valve entirely closed a fresh supply of steam to the expansion tube has arrested the process of contraction. In this way, by slowing down with the toggle, the action of the regulator is made so gradual that with the water above the second gage it is feeding somewhat less than the evaporation, and with the water level below the center gage, it is feeding somewhat more than is being evaporated.

As shown diagrammatically, the regulator triangle is placed so that the lower end of the expansion tube is at the desired low-water limit, and the upper end of the

tube is placed so as to be opposite the highest water level desired. By merely changing the angle of the expansion tube, the variation in the height of the water level between no load and full load can be set at a few inches or a foot as desired, to suit local conditions. The triangle need not necessarily be placed in front of the boiler, as shown. It should, however, be placed as near the water column as possible and in such a position as will bring the ends of the expansion tube at the desired water levels.

The regulator is adjusted so that at normal load the control valve is open just wide enough to keep the water at the desired normal level, usually the second gage; the expansion tube is, therefore, half full of water at normal load.

Any unusual increase in the steam demand lowers the boiler pressure, which in turn lowers the temperature at which the water will boil, and due to the increased heat demanded, the water level will rise suddenly. This sudden rise of water in the expansion tube contracts a section of the latter and through the levers and toggle




NECO FEED-WATER REGULATOR

motion reduces the valve opening sufficiently to decrease the water supply exactly at the moment when little or no cold water is desired. Then, because the boiling temperature has been lowered, a comparatively large amount of water is quickly evaporated to take care of the overload. The water level, being thus lowered, allows a little more steam to enter the expansion tube, and, through the action of the latter, opens the control valve wide enough to take care of the overload, but no more.

This action continues and the steaming capacity increases with every load increase until the safe allowable low limit of water is reached; at this point the expansion tube, being full of steam, reaches its maximum expansion and the control valve opens to its full area.

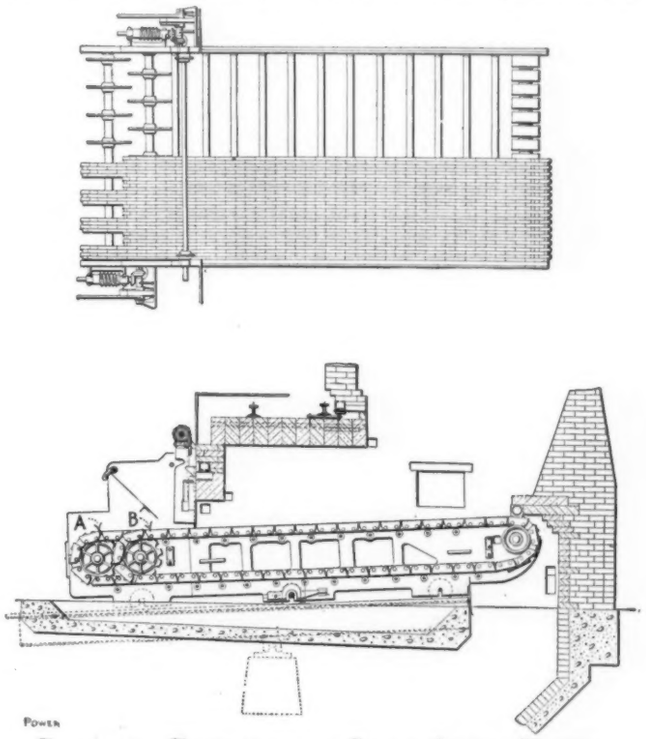
When the load suddenly becomes less, the action is reversed. Closing the draft causes the water level to drop suddenly. The control valve is opened wide and water fed into the boiler until a level is reached, at which point just enough water is fed to supply the evaporation—hence the rate of steaming is automatically retarded and the heat energy, which would otherwise be wasted in steam escaping through the pop valve, is used to heat the additional water.

The design of the regulators is such that full valve opening is secured only when the expansion tube is fully expanded, and the control valve can be shut only when the expansion tube is completely contracted. Full expansion occurs only when the tube is full of steam and it is impossible to secure this except when the water has receded to the lowest desired level. Also, complete contraction occurs only when the tube is full of water, and this can occur only when the high desired level has been reached.

## Illinois "Type B" Chain-Grate Stoker

A chain-grate stoker, different in some respects from others, is illustrated herewith, and the principle on which the grate operates is described. Fig. 1 is a longitudinal section through the stoker and setting, and shows a new feature in arch construction, the novel feature of tilting the stoker for varying the discharge at the rear of the grate, and the means by which the "slicing" action of the grate is produced.

The grate is made up of two sets of strands of links *A* and *B*. Each strand is approximately 6 in. wide. The relative position of these strands is indicated by Fig. 2. Each set is operated by its own mechanism, as shown,




PLAN AND ELEVATION OF CHAIN-GRATE STOKER

which intermittently starts and stops its respective set of strands.

The drives are so arranged that, while, say, the longest strands are in motion, the shorter strands are at rest, then the shorter strands advance, and the longer strands remain stationary.

Since the two sets of strands move an equal distance each time they advance, and each remains stationary the same length of time, the coal is uniformly supplied across the width of the grate. This automatic and continual slicing prevents a crust forming over the top of the fuel bed, and an adequate supply of air can be introduced and brought in contact with the fuel.

Any kind of coal can be economically burned by regulating the periodic time for starting and stopping the strands, and thereby increasing or decreasing the "slicing" effect.

This stoker is manufactured by the Illinois Stoker Co. Alton, Ill.

## Mesta Single-Stage Air Pump

A new design of reciprocating air pump has been placed on the market by the Mesta Machine Co., of Pittsburgh, Penn. A section of the cylinder and an elevation is shown in Fig. 1. The steam cylinder, which is arranged

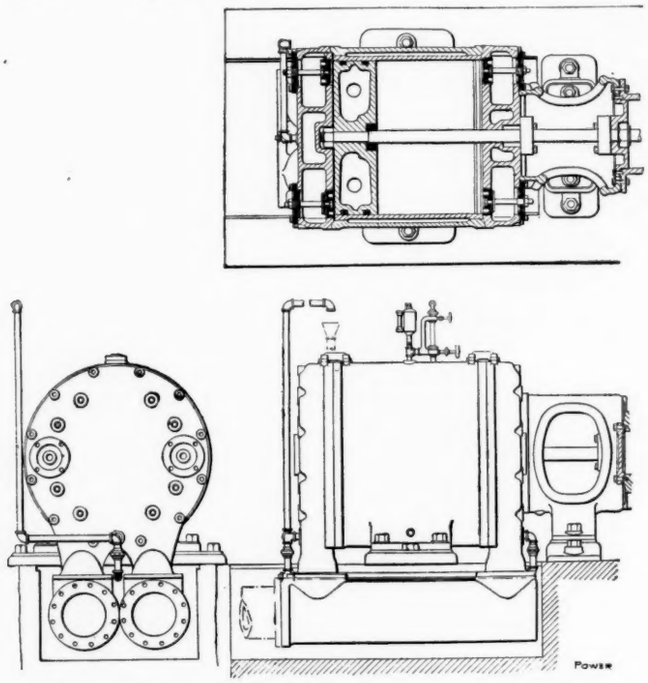


FIG. 1. SECTION AND ELEVATION OF AIR CYLINDER

in tandem and provided with a Meyer valve gear, is omitted. The feature of the air cylinder is the automatic multiported valves of the plate type, which follow in design the Iversen patent. The construction of the valve is shown in Fig. 2. A thin annular steel plate is

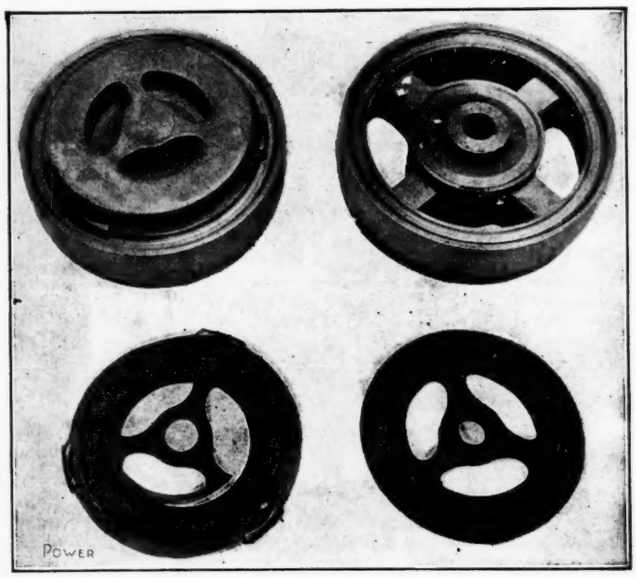


FIG. 2. PARTS OF AIR VALVE

guided without friction by a volute spring. The upper view at the right shows the seat which is bolted to a plate attached to the cylinder head. The four ports in the seat are visible, and in the view at the left the plate is shown in place. The movement of this plate is controlled by the pressure or suction in the cylinder, the spring furnishing the small force necessary to start the closing motion of the valve at the right time. Reference to Fig. 1 will show the location of the valves in the cylinder. Two discharge valves are located on one side, and two suction valves on the other. Due to the construction of the valves the clearance space is very small.

One of these pumps was set up in the works of the company and subjected to a thorough test by Prof. W. Trinks, of the Carnegie Institute of Technology. A tank was arranged in the suction line to convert the pulsating suction of the pump into a steady flow, so that the actual quantity of air taken into the pump could be measured by a standard nozzle. Another nozzle was provided at the side of the tank for admitting vapor to duplicate conditions existing in condenser practice. The steam passing through the engine was condensed at atmospheric pressure in a surface condenser located in the pit under the flywheel, and the condensation was measured in barrels.

When it came to plotting the results of the test, it was decided that it was not feasible to give the steam

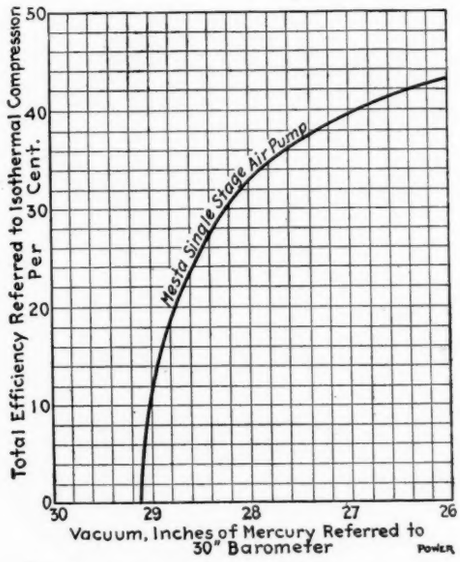



FIG. 3. EFFICIENCY CURVE OF PUMP

consumption per cubic foot of air pumped, as the steam consumption must necessarily vary with the vacuum, the efficiency of the air pump and the efficiency of the prime mover. To separate the two efficiencies, the ratio of the ideal work required for isothermal compression divided by actual work (including all friction work of the engine) required, was plotted against the vacuum referred to a 30-in. barometer. Reference to the curve will show that the pump dropped off rapidly in efficiency above 29 in. of vacuum, and becomes useless for vacuums higher than 29.1 in. Below 29 in. of vacuum, however, the pump rapidly increases in efficiency, and at 26 in. shows remarkably high results. For high vacuums a compound air pump is now being built and test results will soon be available.

❖

Among the cities which are making practical efforts to abate the smoke nuisance are Baltimore, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Indianapolis, Jersey City, Kansas City, Los Angeles, Louisville, Milwaukee, Minneapolis, Newark, N. J., New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Providence, Rochester, San Francisco, Seattle, St. Louis, St. Paul and Washington.

## Coke vs. Oil as Steamship Fuel

The following report, published in the Vancouver *Province,* on the comparative costs of coal and oil as fuel on two of the C. P. R. British Columbia Coast Service steamships, is of interest, in view of the number of vessels which have recently been built to consume liquid fuel, or have been changed so that either of the two fuels may be used. The costs of coal and oil for the steamship "Princess Victoria" are given herewith:

COAL

| | Per Day |
|---|---|
| 100 tons at $4.50 | $450.00 |
| 9 firemen at $55 a month each | 16.50 |
| 9 trimmers at $45 a month each | 13.50 |
| Food for 18 men | 7.56 |
| Total | $487.56 |

OIL

| | |
|---|---|
| 344.17 barrels, at 90c | $314.25 |
| 6 firemen | 11.10 |
| Food for 6 men | 2.52 |
| Total | $327.87 |

The costs for the Princess Charlotte, a larger vessel and of greater horsepower, are as follows:

COAL

| | |
|---|---|
| 100 tons at $4.50 | $450.00 |
| 13 firemen at $55 a month each | 23.80 |
| 10 trimmers at $45 a month each | 15.00 |
| Food for 23 men | 9.56 |
| Total | $498.36 |

OIL

| | |
|---|---|
| 344.17 barrels at 90c | $314.25 |
| 6 firemen | 11.10 |
| Food for 6 men | 2.52 |
| Total | $327.87 |

## Graphite in Boilers

POWER put it squarely up to manufacturers of boiler graphite to show that their products were not injurious to boilers. This came about after a number of letters had been printed from users all endorsing its scale-removing properties. Then appeared the statement of a naval engineer in a convention paper that it accelerated corrosion. The following is a report on this matter made for the United States Graphite Co. by the Pittsburgh Testing Laboratory:

United States Graphite Co.,
Saginaw, Michigan.

Dear Sirs—

Referring to your letter of Feb. 13, 1913, and subsequent communications on the subject of the influence of graphite suspended in water upon the rate of corrosion of steel with which the water is in contact, and referring particularly to the opinion expressed by Lieutenant-Commander Frank Lyon, U. S. N., in the "Journal" of the American Society of Naval Engineers, Vol. 23, No. 4, and Vol. 24, No. 3, we beg to say that while we agree in some respects with Lieutenant Lyon, we differ entirely from him in other particulars.

In the "Journal" of the A. S. N. E., Vol, 23, No. 4, pages 1080 and 1081, in the course of a paper on boiler compounds, Lieutenant Lyon classes graphite with hydrochloric acid under the heading "Dangerous Compounds." He does not claim, however, that graphite is an acid nor that it is a solvent for steel. He bases the analogy between graphite and hydrochloric acid on the alleged fact that both corrode the metal underneath boiler scale, and so cause its removal.

He further states that "steel boiler plate immersed in distilled water containing graphite in contact with the metal corrodes from 200 to 400 per cent. faster than specimens from the same plate immersed in the same water without the graphite, all other conditions remaining the same. The amount of corrosion varies with the purity of the graphite and with the amount of it in contact with the metal.

He also says in Vol. 24, No. 3, p. 858, "With boiler-plate steel in distilled and sea waters containing graphite, pieces covered with graphite lost from 3 to 4 times as much per square inch of area exposed as did similar pieces placed in the same water without graphite. The increased rate of corrosion depended to quite a large extent upon the percentage of area covered and also upon the purity of the graphite."

This is not a fair statement because the experiments were apparently not made under boiler conditions, but were conducted in the open air with free access of oxygen.

It is well known that under these conditions graphite and other forms of carbon do accelerate rusting of steel in water, but when no other air is admitted to a boiler except the air dissolved in the water, the conditions for corrosion by atmospheric oxygen are not favorable. The presence of graphite in a boiler would not stimulate corrosion perceptibly, because of the very limited oxygen supply and also because the steel surfaces are rarely free from a thin covering of some sort, which would insulate the graphite particles from actual contact with the steel.

It should be clearly understood that graphite is in no sense a corroding agent of the acid type, and it is only connected with corrosion of steel when it is in contact with it in the presence of water and a plentiful supply of oxygen. These conditions do not exist in boilers, and furthermore, the amount of graphite ordinarly used (3 oz. per 1000 gal.) is so small as to be insignificant, even if boiler surfaces were always clean and oxygen were freely supplied.

In order to answer by direct experiment Lieutenant Lyon's statement that graphite in water causes steel to corrode 3 to 4 times as rapidly, we made the following tests:

1. Distilled water.
2. Distilled water with graphite (30 oz. per 1000 gal.).
3. Artificial sea water.
4. Sea water with graphite (30 oz. per 1000 gal.).

350 c.c. of boiling water was used for each test, and the water which evaporated was replaced with hot distilled water. After boiling all day, the surfaces of the solutions were covered with melted paraffin. This served to only imperfectly exclude the air.

The experiments began Mar. 19. After Mar. 21, the specimens of steel stood in the beakers till Mar. 27, so that the total time in the water was 8 days, of which only 13½ hours represented actual boiling.

Rusting took place in all cases. The original weights and losses in weight are given below:

| | Original weight grams | Loss in weight grams |
|---|---|---|
| 1. Distilled water | 6.5039 | 0.0126 |
| 2. Distilled water with graphite | 6.7885 | 0.0179 |
| 3. Artificial sea water | 6.6608 | 0.0193 |
| 4. Sea water with graphite | 6.5515 | 0.0175 |

It will be observed from the above tests that in the presence of 10 times as much graphite as is ordinarly used for boiler-water treatment and with a somewhat limited oxygen supply, there is really no material difference in the rates of corrosion. The amount of corrosion was slightly less in sea water containing graphite and slightly more in pure water containing graphite, but these differences are, in our opinion, not sufficiently marked to be significant. They certainly do not bear out Lieutenant Lyon's figures.

Although not representing boiler conditions, we have endeavored to repeat Lieutenant Lyon's experiments of subjecting steel in open vessels to the action of boiler water, with and without graphite.

In these experiments we used water containing 3 oz. of graphite per 1000 gal., and we found in this case also, after a number of hours boiling, that there was no material difference in the losses of weight of the steel specimens.

Yours truly,
Pittsburgh Testing Laboratory,
JAS. A. HANDY,
Research Director.

## Building Managers' Convention

The sixth annual convention of the National Association of Building Owners and Managers was held at Cincinnati on June 10 to 13, inclusive. The business sessions of the association and the exhibit of the machinery and supply houses were both held in the Music Hall.

An ample entertainment program was provided which included a long automobile ride and a dinner at the Zoological Gardens on Wednesday and an excursion on the Ohio River to Coney Island, Thursday.

At the election on Friday the following officers were chosen: President, J. E. Randell, Chicago; vice-president, C. E. Doty, Cleveland; secretary, C. A. Patterson, Chicago, re-elected; treasurer, L. L. Banks, Pittsburgh.

The next convention will be held at Duluth.

Two or three of the papers presented should be of general interest to our readers and these will be abstracted in early issues.

# Influences Affecting American Engineering Practice*

By WILLIAM FREEMAN MYRICK GOSS, M. S., D. Eng.†

[The theme presented by this adress was selected by the American Committee on Arrangements for the Leipzig meeting, and is in part the result of suggestions received from German sources. In its development important assistance has been rendered by a number of individuals, each of whom has generously submitted by way of suggestion a brief covering some one of the topics which the author had chosen for presentation.—Author.]

We have come to this country in response to an invitation from the largest organization of professional engineers that the world has thus far seen, and we approach your threshold thoughtfully. We remember your history and understand something of the debt of obligation which engineers everywhere owe the scientists of the German Empire. We recall the fact that foundations for the development of mathematical truth were laid by Gottfried Wilhelm Leibnitz, born more than 250 years ago in this city of Leipzig, and we know the later work of Euler, and the present-day contribution of Professor Klein. We do not forget that modern engineering has profited greatly by the discoveries of chemists, like Bunsen, Baeyer and Liebig, and of the physicists like Helmholtz, Hertz, Nernst and Roentgen. As steam engineers, we recognize our debt to Clausius, Robert Mayer and to Hirn, to Zeuner, Koerting, von Linde, and Stodola. As manufacturers, we find interest in the great accomplishments of August Borsig, of Alfred Krupp, and of Werner von Siemens. A study of the internal-combustion engine leads at once to the achievements of Otto, Langen, Daimler and Diesel; students of locomotive performance know well the work of von Borries and Wilhelm Schmidt; and the success of your great national museum has kindled our enthusiasm for its Director, your distinguished State Councilor, your energetic president, our good friend, Dr. Oskar von Miller.

In the United States as elsewhere, the percentage of the total population engaged in trade, manufacturing, mining and transportation has increased, and the percentage engaged in agriculture has diminished. These changes have attended the growth of the country's engineering activities. The transfer from agriculture to other pursuits has proceeded because people felt the need of transportation, of implements, and of conveniences in many different forms which can be supplied only by nonfarmer labor. The process of supplying these needs has constituted the engineer's opportunity. If his methods in the production of coal are wasteful, it must be remembered that in the United States coal in the ground is of little value, and that for several decades past the demand for output has doubled the annual coal production of the United States every ten years.

If some of his American railroad construction lacks qualities thought essential in European practice, it must be remembered that in the United States there is today but one family for each 100 acres of land and that the engineer's problem has been to supply transportation facilities not only between great cities, but also over vast areas of thinly populated territory. If it happens that a railroad designedly of a secondary character is made to render service which in speed and weight of trains should only be expected of a better-constructed and better-equipped road, the mistake may be serious, but the error is more likely to be one in management than in engineering.

## INDUSTRIAL DEVELOPMENT

In development of manufacturing industries the American engineer has responded to similar influences. Whatever may have been the nature of the thing manufactured, if it met a real need, an extensive market was immediately at hand, The making of sewing machines and other conveniences of the home, of structural-steel shapes, railway iron, locomotives, railway cars, railway signal equipment, machinery, electrical apparatus, power-plant equipment, and more recently of automobiles and autotrucks, has pushed the ability of factories to the utmost and necessitated a constant increase in capacity. In many lines of endeavor the requirements of a new, extensive and growing country have made it possible to produce enormous quantities, and this fact has had its influence on the methods employed in manufacture.

One result of the very great demand for manufactured articles has been the exaltation of the machine. The high cost of labor also has stimulated its introduction. The general-purpose machine has steadily given way to machines designed to perform specific operations. The engine lathe, which was formerly a dominant figure in most metal-working establishments, and which is still useful in general repair work, is now regarded as an expensive tool for specific manufacturing purposes.

The extensive use of special machinery in any manufacturing industry imposes heavy responsibilities upon its engineering staff. The various steps to be taken in fabricating the article are reduced to the smallest practicable number, are made as direct as possible, and proceed in a predetermined order. Then the machines to be employed are selected, or if not available, are designed and constructed. When the establishment begins its operations, the part each operator is to perform will have been defined. The development of these matters is for the most part a task for the engineer, and one result which has attended the extensive use of special machinery in the manufacturing industries of the United States, is to be seen in the numerical growth and in the increased technical strength of their engineering staffs.

The importance attaching to the machine as a factor in industrial production has emphasized the necessity of maintaining equipment in a high state of efficiency. Machines, even when too new to be in need of repair, should sometimes be thrown out to make room for those of higher efficiency or greater capacity.

If the manufacturers of the United States have been more ready than the people of other countries to proceed with such changes, they have had a greater incentive for so doing in the higher price of their labor, for the higher the cost of labor, the greater the amount of capital which may be spent in replacing existing machines, or in installing new machines for the purpose of reducing labor costs.

## TENDENCY TO COMBINATIONS

In the development of American engineering industries, there has ever been a tendency to combine undertakings. Short lines of railroads have been joined to form longer lines, and these in turn have been consolidated into greater systems. Manufacturing establishments producing similar products or similar groups of products have been united to form a great corporation under a single management, and these combinations have brought about great concentration of effort and output, the volume of which has had its effect in modifying the developing engineering practice.

Through combination, public-service companies have achieved results equal in significance to those obtained by the manufacturer. In the absence of combined effort, the business of supplying a city with electrical energy is divided among several interests. One company may maintain a power station and a distributing system for electric-lighting, another a similar station and distributing system for street railway power, another may serve interurban railways, another steam-railway terminals, and other companies may supply electrical energy to miscellaneous consumers for commercial purposes.

In contrast with this, now stands the single public-service corporation, which is equipped to supply a whole community with electricity for all purposes, rather than to supply a portion of that which is needed in competition with or duplicating the facilities of other companies. The volume of the combined business permits the elimination of many small and inefficient generating units and the substitution therefor of large units of the highest practicable efficiency. Under a single ownership duplication of feeder lines and distributing facilities may be avoided. When current can be drawn from any source of supply to any point of consumption, the reserve power to meet emergency demands may be less than when divisions of the whole system must rely upon their own sources of supply. The peak loads of different classes of service occur at different hours of the day, and at different seasons of the year. When all classes of service are combined into a single system, the load factor is improved and the amount of installed power required to supply the service is reduced by this diversity factor.

These considerations may easily allow a single public-service corporation, supplying a community with electricity for all purposes, to perform its function with a power installation, the cost of which may be from 30 to 60 per cent. less than that which would be required in an uncombined duplicative service. Obviously, a corporation rendering such a consolidated service to a single city may extend its operations to a group of cities and to the intervening country. Under favorable conditions, the greater the area of territory over which the system spreads, and the greater the number of interests served, the greater will be the load factor of the system provided the single system is permitted to fur-

*Extracts from the address prepared by the president of the American Society of Mechanical Engineers and delivered at the joint meeting with the Verein Deutscher Ingenieure at Leipzig, Germany, June 23, 1913.

†President of the American Society of Mechanical Engineers, Dean of the College of Engineering, University of Illinois.

nish the entire electric service within the areas covered. The maximum limit to which such a system may be extended has not yet been reached in American practice, though in certain large cities of the United States a single large corporation is now serving electricity for all purposes, and the same is true of groups of towns, often covering hundreds of square miles of rural territory.

The advent of the great corporation has introduced new problems in organization. The early conception that such corporations could be directed and controlled by administrative methods identical with those which had served for smaller ones has not been justified. Different organizations have worked out different solutions, but the tendency in all cases has been to subdivide the administrative function in such a way that business may be expedited without diminishing the advantages of centralized control.

### SCIENTIFIC MANAGEMENT

Among the significant movements which have affected recent engineering practice in the United States is the campaign for higher efficiency in operation, best known as "scientific management." This assumes that there is one best way for doing everything; that if practice is diverse, it is because all factors affecting it are not known; and that "the best management is a true science resting upon clearly defined laws, rules and principles as a foundation." The development of scientific management involves, first, the discovery, and, second, the application of the laws, rules and principles which control each particular problem. Applicants for positions are examined that the unfit may be rejected and that the precise nature of the work to which the accepted individuals are best adapted, may be determined. The selected man is then trained in the performance of his task.

The effect of scientific management upon the workman himself appears to be entirely satisfactory. His wage has often increased to limits never before reached by artisan or laborer and he is a contented as well as an effective workman. Its effect upon the industry also is favorable, since whatever increases the output of the individual workman tends to increase the earning capacity of the plant.

Again, the principle that a man to do his best at work must be in good physical condition, is receiving recognition. The man of whom such is expected must have rest and proper food. The home life of the workman, therefore, becomes an important factor in the efficiency of the industry. In many of these matters American industries have in the past been shamefully negligent, and it is interesting, though perhaps not entirely creditable, that attention should now be given them chiefly as an outgrowth for a campaign for increased industrial efficiency. In the development of this aspect of scientific management, America is finding much to emulate in German practice.

### EDUCATION

The activities of the American engineer have been supplemented and greatly stimulated by the influence of various educational processes. Illiteracy in America is rare. The normal child of the most humble worker is taught something of the facts of science, history, and literature. The elementary public schools commonly provide eight years of training and carry the pupil until he is 14 years of age. If he is able to delay efforts in self-support beyond this age, the public high schools afford four addition years of training for both boys and girls, in the classics, in languages, in mathematics and in science. Girls may be trained also in the various departments of domestic science, and boys in the mechanic arts. The high school prepares for the work of the university or for the technical school. Following the excellent models developed by your own Professor Kirchensteiner, of Munich, vocational schools paralleling the first two years of the high school are likely soon to become common.

Important also among educational influences are the daily newspapers abounding in the discussion of questions of public interest and giving not only the local news, but the world's news. In quite another class are the trade journals. These are published weekly or monthly, are attractive in form and present readable and instructive material of interest to the particular classes of men to which they make their appeal.

Important also among the influences which are effective in education, are many semiscientific and semitechnical organizations which enroll large numbers of members, hold meetings, or conventions, at fixed times, and publish the proceedings of these meetings for the benefit not only of members, but of any one who may be interested. Whenever men's work causes them to fall into groups, they are likely to have their organization and their organization's publication. In addition to the publications of organizations, there are the high-grade technical magazines or journals, and the published proceedings of the more strictly scientific and engineering socities. Taken altogether, they furnish an educational influence of tremendous import. The wise industrial manager encourages all who are responsible to him to read and he also reads. The result is a free and altogether helpful interchange of experiences and opinion. Trade secrets are practically unknown. What one man gains another may have. In manual arts, in science and in engineering, the practice of the country is an open book.

Finally, standing high among the educational factors which are influential in the development of American industries, must be mentioned the university and the technical school. As compared with those of Germany, the American technical school has been a plant of slow growth. The technical schools in the beginning emphasized the more practical aspects of engineering, leaving the matters of mathematical theory for a later time. From such simple beginnings the schools have made steady progress. Today there is nowhere in America a keener appreciation of the service which such sciences as mathematics, physics, chemistry and biology can render engineering than in the technical school. The schools are revising courses of study and they are emphasizing the fundamental methods and facts of science rather than the more easily acquired practical aspects of engineering.

Many of them, following the example so effectively set forth by the German Hoch Schule, are making contributions to engineering research, and their outlook towards science as a basis for all technical development constitutes one of the most promising aspects of our educational work. The bond between the industries and the schools, which in earlier days was uncertain, has in recent years been tremendously strengthened. The industries are now looking to the schools for the men who are to be their leaders; for facts which will be serviceable in the promotion and development of their business; and for the stimulus which is to transform present-day practice into the more perfect procedures which our ideals demand.

## Cheap Electricity for Buffalo

An important decision was handed down by the New York Public Service Commission of the Second District a few weeks ago when it declared the rate schedule of the Buffalo General Electric Co. discriminatory, and thereupon set about to prescribe a new schedule based solely upon what it considered a fair return upon the investment.

This action was brought about as the result of a complaint by Louis P. Fuhrmann as mayor of Buffalo against the Buffalo General Electric Co. and the Cataract Power & Conduit Co. The latter purchased power from the Niagara Falls Power Co., and in turn delivered it at the city line to the Buffalo General Electric Co. for $25 per electric horsepower of maximum demand.

As was expected, the companies made every effort to boost the value of their investments and the Buffalo's General Electric Co. endeavored to include a franchise value of about $2,000,000 as well as a contract with the General Electric Co. of Schenectady in which the latter received some $700,000 in stocks and bonds, but for which the Buffalo company appears to have received nothing in return except the good will of the other company. Other intangibles which the defendant strove to have included in its investment value were an alleged contract with the Cataract Power & Conduit Co. and a "going concern value."

The greater part of these claims were denied by the Public Service Commission, its opinion with reference to the franchise value being summed up in the following words:

"If the franchise, which was a gift from the public to the company, should be made the basis of a money return, the practical result would be that the public would have to pay money to the company because it had given the company the right to occupy the public streets."

The Public Service Commission first ordered the Cataract Power & Conduit Co. to reduce its price to the Buffalo General Electric Co. by 28 per cent., and then prescribed the following rate schedule for the latter company which represents an average reduction of 25 per cent. in its former schedule:

### MAXIMUM RATES FIXED BY THE COMMISSION

**Residence Lighting**—Available for residence consumers only.

Connected lighting load in kilowatts to be determined by actual inspection. Maximum demand to be assumed to be one-quarter of connected load.

Net rate: 7s. per kw.-hr. for first 60 hr. use of maximum demand; 4c. per kw.-hr. for next 120 hr. use of maximum demand; 1½c. per kw.-hr. for remainder.

**General Lighting**—Available for all lighting except residences.

Connected load in kilowatts to be determined by actual inspection. Maximum demand to be assumed as one-half of connected load.

Net rate: 7c. per kw.-hr. for first 60 hr. use of maximum demand; 4c. per kw.-hr. for next 120 hr. use of maximum demand; 1½c. per kw.-hr. for remainder.

**General Power**—Available to all power customers.

Connected load in kilowatts to be determined by actual inspection. Maximum demand to be assumed as three-quarters of the connected load.

Net rate: 7c. per kw.-hr. for first 30 hr. use of maximum demand; 3½c. per kw.-hr. for next 40 hr. use of maximum demand; 1c. per kw.-hr. for remainder.

**Large Light and Power**—Available for all consumers willing to guarantee a maximum demand of 10 kw.

Maximum demand determined by maximum demand meter.

Net rate, demand charge: $2.75 per kw. for first 10-kw. demand; $1.50 per kw. for each additional kilowatt demand. Energy Charge: 1c. per kw.-hr. for all energy used.

Gross rate, demand charge: $3 per kw. for first 10 kw. demand; $1.75 per kw. for each additional kilowatt demand. Energy Charge: 1c. per kw.-hr. for all energy used.

It is interesting to compare these rates with those at present in force with the New York Edison Co., which are as follows:

**General Rate**—Available for all consumers. The first 250 kw.-hr. of monthly consumption at 10c. per kw.-hr. Next 250 kw.-hr. of monthly consumption at 10c. per kw.-hr.; next 250 kw.-hr. of monthly consumption at 9c. per kw.-hr.; next 250 kw.-hr. of monthly consumption at 8c. per kw.-hr.; next 250 kw.-hr. of monthly consumption at 7c. per kw.-hr.; next 500 kw.-hr. of monthly consumption at 6c. per kw.-hr. Excess over 1500 kw.-hr. of monthly consumption (for the excess) at 5c.

**Power Rate**—The first 200 kw.-hr. of monthly consumption at 9c. per kw.-hr.; next 200 kw.-hr. of monthly consumption at 8c. per kw.-hr.; next 2500 kw.-hr. of monthly consumption at 6c. per kw.-hr.; excess over 2900 kw.-hr. of monthly consumption (for the excess) at 5c. per kw.-hr.

**Wholesale Rate**—First 100,000 kw.-hr. yearly consumption at 5c. per kw.-hr.; next 100,000 kw.-hr. yearly consumption at 4c. per kw.-hr.; over 200,000 kw.-hr. excess yearly consumption at 3c. per kw.-hr.; 500,000 kw.-hr. yearly consumption not to exceed $17,500; 625,000 kw.-hr. yearly consumption not to exceed $20,000; 833,333 kw.-hr. yearly consumption not to exceed $25,000; yearly guarantee, Manhattan, 100,000 kw.-hr.; Bronx, 60,000 kw.-hr.

Assume for comparison first the case of a small consumer, whose residence contains a connected load of one kilowatt. Let his monthly consumption be 15 kw.-hr. Under the revised Buffalo rates his monthly bill would be $1.05 whereas in New York he would pay $1.50.

Next assume a customer who uses somewhat more current. Let his connected load be 1.6 kw. and assume that his monthly consumption is 60 kw.-hr. Under the present Buffalo schedule he would pay $3.12. If he lived in New York his monthly bill would be $6 or practically double. The class of consumers in which the comparison is most striking, however, is the storekeeper on one of the narrow streets, who in winter is compelled to burn his lights all day long. There are a large number of this class in New York. Assume his connected load to be 1.5 kw. and he will use on an average about 250 kw. per month for which he will pay the New York Edison Co. $25. This same customer in Buffalo would pay only $7.50.

Although the price paid by the Buffalo General Electric Co. to the Cataract Power & Conduit Co. may at first seem low, it should be remembered that it is based on the kilowatts of maximum demand; that is, if the peak load for an hour or even a few minutes of the day is 10,000 kw., but the average for the day is only 5000 kw., the company still has to pay for 10,000 kw. for the whole 24 hr. Hence the average price paid by the Buffalo company is about double that which appears in the contract.

This average price per kilowatt-hour under the revised rate is approximately the same as the production costs per kilowatt-hour at the switchboard for the New York Edison Co.—a fact which discredits any contention as to the cheapness of the water power from Niagara. It is fair to assume then that the average distribution and overhead charges per kilowatt-hour for the two companies would not differ greatly. Hence the total costs should compare favorably.

❖

The total area of the coal fields in Georgia is estimated at 167 sq.m., the smallest coal area in the Appalachian States.

# Government's Water-Power Contract Policy

"The lower the rate charged to consumers by electric-power companies the lower will be the tax which such power companies must pay to the government." Secretary Lane of the Interior Department announced this as "the heart of the policy adopted as to the disposition of water rights of the government.

Secretary Lane says these contracts are just, alike to seller rights to use the public lands and the waters of navigable streams for the development of electrical power. He is opposed to using these waters as a source of revenue to the government, but favors the fullest use of them for the benefit of the people.

After carefully considering a power project on the Pend d'Oreille River, in northern Washington, the secretary has laid down five conditions as "an ideal standard toward which to work the making of the contract between the government and the applicants for the use of the power."

1. The greater the development of horsepower, the lower the charge per horsepower to be made on the part of the government. This is intended to secure the full use of the stream.

2. The lower rate to consumers, the lower the charge on the part of the government.

3. No charge whatever for a period of five to ten years, during which the power company is finding its market.

4. Acceptance as a public utility of the state's jurisdiction over intrastate rates and service, and of Federal jurisdiction over interstate rates and service.

5. Absolute prohibition of combination or monopoly, and the right of revocation on the part of the government in the event that it is established to the satisfaction of the Secretary of the Interior or the courts that such combination has been made or that prices have been fixed by agreement with competing plants.

Secretary Lane says these contracts are just, alike to seller and consumer of the power; they are fair to the government, and they will make for the conservation and genuine development of great natural resources which are now going to waste.

❖

# Boiler Tube Bursts in New York Hospital

At 4 a.m. Thursday, June 19, a 4-in. tube of one of the two 80-hp. water-tube boilers in the Beth Israel Hospital, Jefferson St., New York City, burst, blowing the fire from the grates, injuring the engineer and a policeman and setting fire to the building.

At the time of the accident the boiler was under 110-lb. pressure. The burst tube was the first or right-hand one in the bottom row immediately over the grate. Mr. Taylor, the chief engineer, states that the tube was a new one having been put in about Oct. 15, 1912. The tubes in both boilers were cleaned thoroughly with a turbine cleaner last October.

The rip is about 2½ ft. from the front end, and is approximately 12 in. long and 8 in. wide in the center; the side next the furnace having been blown out and flattened against the wall.

The burst was undoubtedly due to a defect in the tube, as it is thin where it ripped. It appears that the tube did not become overheated because there was plenty of water in the boiler and there is no scale in the tube, even beyond the ripped portion.

Although the engineer's office is about 35 ft. in front of the boiler (a bad location), the hot coals were blown against the woodwork, starting a fire which did damage amounting to about $25. The boiler was regularly inspected by both insurance and city inspectors.

## PERSONALS

Arthur Main, formerly electrical engineer of the Hot Springs (Ark.) Water & Light Co. is now electrical engineer of the Mammoth Springs (Ark.) Power Co.

J. H. Bissell, formerly assistant treasurer of the Paducah Traction Co. and the Paducah Light & Power Co., Paducah, Ky., has been appointed assistant treasurer of the Mississippi River Power Co. at Keokuk, Ia.